Welcome back

17 March 2021

Table of contents

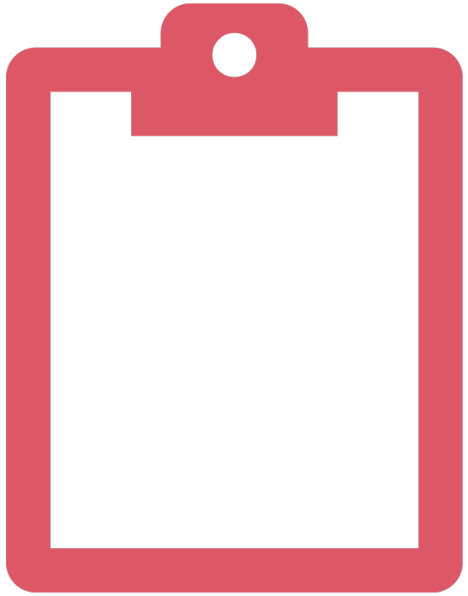
01
RE-CAP

Module C: Stationary energy

Module C: Stationary energy

Overview 01	Fuel combustion 02	Fugitive emissions 03	Grid-supplied energy consumption 04
Case studies 05	Practical 06		

Practical



Practical

Task 3: Stationary energy

Table		Steps
1a	Find activity data and convert to TJ	• Copy ktoe value from NEB 2017 Table 29 to workbook (columns C,E and G) • Convert ktoe values to TJ by multiplying ktoe by 41.868 (columns: D,F and H)
1b	Identify scaling factor and scale data to city boundary	• Copy activity data in TJ from 1a (column: C) • Identify suitable scaling factor for I.1, I.2 and I.3 : population or GDP (column: D) • Copy national population and GDP values from BUR3 Table 1.15 (column: E) • Record city population and GDP values (use Kuala Lumpur as default) (column: F) • Determine ratio by dividing city value by national value (column: G) • Multiple activity data by ratio to scale national data to city boundary (column: H)
1c	Find emission factors and convert to tGHG/TJ	• Copy emission factors per fuel type from BUR3 Table A2 (columns: C,E and G) • Convert tC/TJ to tCO_2/TJ by multiplying by 44/12 (column: D) • Convert kgCH_4/TJ and kgN_2O/TJ to tGHG/TJ by dividing by 1000 (columns: F and H) • For electricity: convert tCO_2/MWh to tCO_2/TJ by dividing by 0.0036 (column: D)
1d	Estimate GHG emissions	• Multiply activity data (from 1b) by emission factor (1c) (columns: C,D and F) • Apply GWP factors to CH_4 and N_2O (columns: E and G) • Sum all CO_2, CH_4 and N_2O emissions (column: H)

Clarifications

Language

- Gasoline = petrol
- Coal & coke = sub-bituminous coal
- Commercial & Industrial >> Commercial & Institutional

Emission factors

- Natural gas (manufacturing / construction) = 1 $kgCH_4/TJ$
- Natural gas (residential / commercial) = 5 $kgCH_4/TJ$
- For the purpose of the exercise, use the EF for manufacturing as industrial use of natural gas >> residential and commercial use of natural gas
- To convert from tCO_2/MWh to tCO_2/TJ (electricity EF) **divide** by 0.0036

Table A2: Summary of Emission Factors Used

		Emission factors								
		CO_2 (tC/TJ)	CH_4 (kg/TJ)	N_2O (kg/TJ)	HFCs	PFCs	SF_6	NF_3	NO_x	CO
ENERGY										
1A Fuel Combustion Activities										
1A1 Energy Industries										
1A1a	Electricity and Heat Production									
1A1ai	Electricity Generation									
	Diesel oil	20.2	3	0.6						
	Residual Fuel Oil	21.1	3	0.6						
	Sub-bituminous coal	26.2	1	1.5						
	Natural Gas	15.3	1	0.1						
1A1 b	Petroleum Refining									
	Crudel oil	20.0	3	0.6						
1A1 c	Manufacture of Solid Fuels and Other Energy Industries									
	Natural gas	15.3	1	0.1						
1A2 Manufacturing Industries and Construction										
	Gasoline	18.9	3	0.6						
	Other kerosene	19.6	3	0.6						
	Diesel oil	20.2	3	0.6						
	Residual Fuel Oil	21.1	3	0.6						
	LPG	17.2	1	0.1						
	Sub-bituminous coal	26.2	10	1.5						
	Natural gas	15.3	1	0.1						
1A3 Transport										
1A3 a	Civil Aviation									
1A3 aii	Domestic Aviation									
	Jet kerosene	19.5	0.5	2						
1A3 b	Road Transportation									
	Natural gas	15.3	92	3						
	Gasoline	18.9	33	3.2						
	Diesel Oil	20.2	3.9	3.9						
1A3 c	Railways									
	Diesel Oil	20.2	4.15	28.6						
1A3 d	Water-borne Navigation									
1A3 dii	Domestic Water-borne Navigation									
	Diesel Oil	20.2	7	2						
	Residual Fuel Oil	21.1	7	2						
1A4 Other Sectors										
1A4 a	Commercial/Institutional									
	Diesel Oil	20.2	10	0.6						
	Residual Fuel Oil	21.1	10	0.6						
	LPG	17.2	5	0.1						
	Natural Gas	15.3	5	0.1						
1A4 b	Residential									
	Other kerosene	19.6	10	0.6						
	LPG	17.2	5	0.1						
	Natural Gas	15.3	5	0.1						
1A4 c	Agriculture/Forestry/Fishing/Fish Farms									
1A4 ci	Stationary									
	Diesel Oil	20.2	10	0.6						
	Residual Fuel Oil	21.1	10	0.6						
1A4 cii	Off-road Vehicles and Other Machinery									
1A4 ciii	Fishing (mobile combustion)									
	Diesel Oil	20.2	5	0.6						
	Residual Fuel Oil	21.1	5	0.6						
1A5 Non-Specified										
1A5 a	Stationary									

Table 3: GPC table

Sub-sector		Scope 1	Scope 2	Scope 3
I.1	Residential buildings			
I.2	Commercial and institutional buildings and facilities			
I.3	Manufacturing industries and construction			
I.4	Energy industries			
I.4.4	*Energy generation supplied to the grid*			
I.5	Agriculture, forestry, and fishing activities			
I.6	Non-specified sources			
I.7	Fugitive emissions from coal			
I.8	Fugitive emissions from oil and natural gas systems			

Table 3: GPC table

GPC GHG Summary Tables

BASIC

NAME OF CITY:	London, United Kingdom	**POPULATION:**	8.416.500
BOUNDARY:	Administrative boundary of a local government	**LAND AREA (km2):**	1.595
INVENTORY YEAR:	2013	**GDP (US$ bn):**	481,06

GHG Emissions Source (By Sector)		Total GHGs (metric tonnes CO2e)					
		Scope 1	Scope 2	Scope 3	BASIC	BASIC+	BASIC+ 53
STATIONARY ENERGY	Energy use (all emissions except I.4.4)	13.637.779	16.967.254	1.450.756	30.605.033	32.055.789	32.055.789
	Energy generation supplied to the grid (I.4.4)	2.558.704					
TRANSPORTATION	(all II emissions)	6.224.956	1.064.893	1.034.075	7.289.849	8.323.924	8.323.924
WASTE	Waste generated in the city (III.X.1 and III.X.2)	397.017		1.455.375	1.852.392	1.852.392	1.852.392
	Waste generated outside city (III.X.3)						
IPPU	(all IV emissions)						
AFOLU	(all V emissions)						
OTHER SCOPE 3	(all VI emissions)			NE			
TOTAL		22.818.456	18.032.147	3.940.206	39.747.274	42.232.105	42.232.105

GPC ref No.	GHG Emissions Source (By Sector and Sub-sector)	Total GHGs (metric tonnes CO_2e)			
		Scope 1	Scope 2	Scope 3	Total
I	STATIONARY ENERGY				
I.1	Residential buildings	8.332.651	5.836.566	499.046	14.668.263
I.2	Commercial and institutional buildings and facilities	5.293.341	11.130.687	951.710	17.375.739
I.3	Manufacturing industries and construction	IE	IE	IE	
I.4.1/2/3	Energy industries	IE	IE	NE	
I.4.4	Energy generation supplied to the grid	2.558.704			
I.5	Agriculture, forestry and fishing activities	IE	IE	IE	
I.6	Non-specified sources	NO	NO	NO	
I.7	Fugitive emissions from mining, processing, storage, and transportation of coal	NO			
I.8	Fugitive emissions from oil and natural gas systems	11.788			11.788
SUB-TOTAL	(city induced framework only)	13.637.779	16.967.254	1.450.756	32.055.789

Source: C40

Not estimated (BASIC+ & Other Scope 3)

Sub-sector		Scope 1	Scope 2	Scope 3
I.1	Residential buildings			NE
I.2	Commercial and institutional buildings and facilities			NE
I.3	Manufacturing industries and construction			NE
I.4	Energy industries			NE
I.4.4	*Energy generation supplied to the grid*			
I.5	Agriculture, forestry, and fishing activities			NE
I.6	Non-specified sources			NE
I.7	Fugitive emissions from coal			NE
I.8	Fugitive emissions from oil and natural gas systems			NE

Assume not occurring (I.4 - I.8)

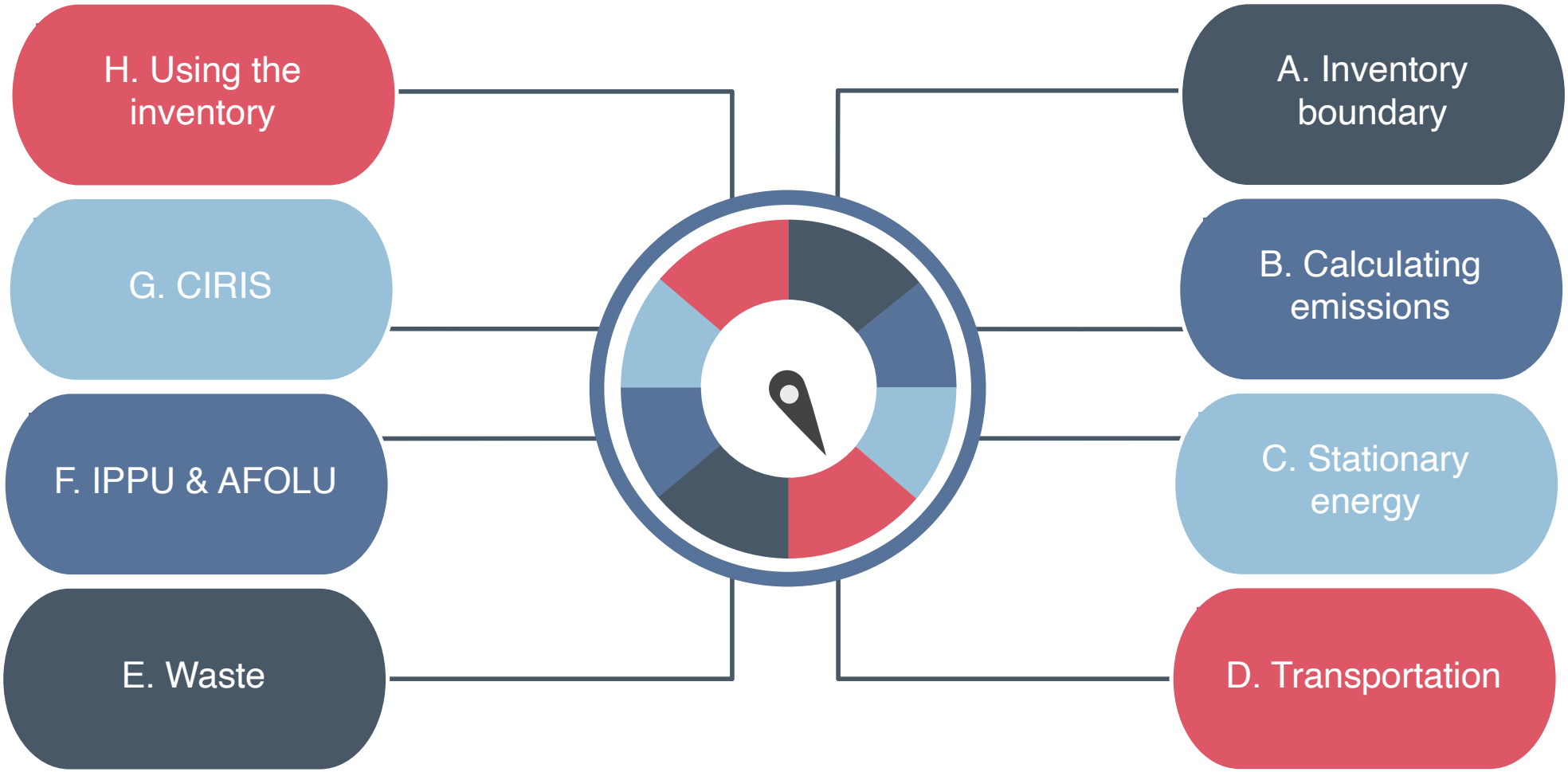
Sub-sector		Scope 1	Scope 2	Scope 3
I.1	Residential buildings			NE
I.2	Commercial and institutional buildings and facilities			NE
I.3	Manufacturing industries and construction			NE
I.4	Energy industries	NO	NO	NE
I.4.4	*Energy generation supplied to the grid*	NO		
I.5	Agriculture, forestry, and fishing activities	NO	NO	NE
I.6	Non-specified sources	NO	NO	NE
I.7	Fugitive emissions from coal	NO		NE
I.8	Fugitive emissions from oil and natural gas systems	NO		NE

From Workbook: Module C Table 1d

Sub-sector		Scope 1	Scope 2	Scope 3
I.1	Residential buildings			NE
I.2	Commercial and institutional buildings and facilities			NE
I.3	Manufacturing industries and construction			NE
I.4	Energy industries	NO	NO	NE
I.4.4	*Energy generation supplied to the grid*	NO		
I.5	Agriculture, forestry, and fishing activities	NO	NO	NE
I.6	Non-specified sources	NO	NO	NE
I.7	Fugitive emissions from coal	NO		NE
I.8	Fugitive emissions from oil and natural gas systems	NO		NE

Table 4: Action plan

GPC	Data	Where from?	Action	Lead
Residential buildings				
Commercial buildings and facilities				
Institutional buildings and facilities				
Manufacturing / construction				
Energy generation supplied to the grid				
Fugitive emissions from oil and gas				


H. Using the inventory
G. CIRIS
F. IPPU & AFOLU
E. Waste
A. Inventory boundary
B. Calculating emissions
C. Stationary energy
D. Transportation

02
MODULE D

Transportation

Module D: Transportation

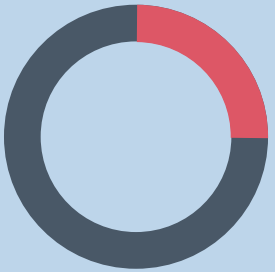
Overview	Transportation methodologies	Practical
01	02	03

Module D: Transportation

Overview	Transportation methodologies	Practical
01	02	03
	Includes: 2x Menti exercises 1x breakout exercise	Includes: 2x breakout tasks 2x homework tasks

Module D

Transportation



01

Overview

Requirements

BASIC	Cities shall report all GHG emissions from combustion of fuels in transportation occurring within the city boundary in scope 1, and GHG emissions from grid-supplied electricity used for transportation within the city boundary for transportation in scope 2
BASIC+	Cities shall report all BASIC sources and scope 3 GHG emissions associated with transboundary transportation
Territorial	

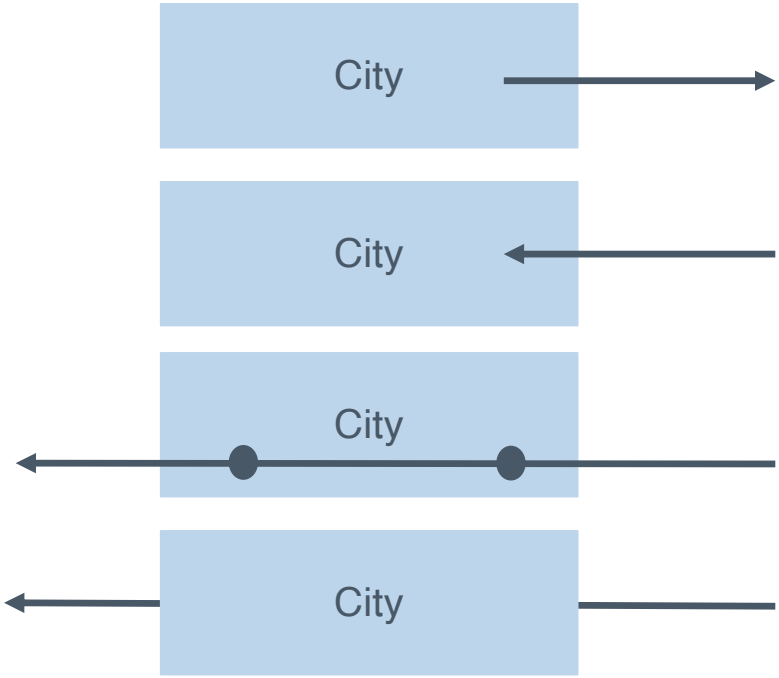
Four types of transboundary trips

Trips that originate in the city and terminate outside the city

Trips that originate outside the city and terminate in the city

Regional transit (typically buses and trains) with an intermediate stop (or multiple stops) within the city

Trips that pass through the city, with both origin and destination outside the city



Categorising emissions

Scope 1	Scope 2	Scope 3
Emissions from transportation occurring in the city	**Emissions from grid-supplied electricity used in the city for transportation**	**Emissions from the portion of transboundary journeys occurring outside the city, and transmission and distribution losses from grid-supplied energy from electric vehicle use**
Scope 1 includes all GHG emissions from the transport of people and freight occurring within the city boundary.	Scope 2 includes all GHG emissions from the generation of grid-supplied electricity used for electric-powered vehicles. The amount of electricity used should be assessed at the point of consumption within the city boundary.	This includes the out-of-city portion of all transboundary GHG emissions from trips that either originate or terminate within the city boundaries. This may include the out-of-city portion of on-road transit that burns fuel, or any out-of-city stops for an electric railway.

Sub-sectors

Sub-sector		Definition
II.1	On-road	All emissions from energy use by electric and fuel powered cars, taxis, buses, trucks, motorcycles, etc.
II.2	Railways	All emissions from energy use by including trams, urban railway subway systems, regional (inter-city) commuter rail transport, national rail system, and international rail systems, etc
II.3	Waterborne navigation	All emissions from energy use by sightseeing ferries, domestic inter-city vehicles, or international water–borne vehicles
II.4	Aviation	All emissions from energy use by helicopters, domestic inter-city flights, and international flights, etc.
II.5	Off-road	All emissions from energy use by ground support at transportation hubs, forklifts, snowmobiles, etc.

Transportation overview (GPC)

Transportation sub-sectors	Scope 1	Scope 2	Scope 3
On-road	II.1.1	II.1.2	II.1.3
Railways	II.2.1	II.2.2	II.1.3
Waterborne navigation	II.3.1	II.3.2	II.3.3
Aviation	II.4.1	I.4.2	II.4.3
Off-road	II.5.1	II.5.2	II.5.3

Common Reporting Framework

CRF inventory requirements are fully aligned with the GPC. Minor differences:

Transportation
On-road and Railways *should* be disaggregated by fleet type:

- Municipal transport
- Public transport
- Private transport
- Commercial transport

Sectors and sub-sectors in GCoM reporting framework	IPCC (ref no.)	GPC (ref no.)	European CoM reporting framework (subject to revision)
Stationary Energy			Final energy consumption in the 'buildings, equipment/facilities, industries' sector
Residential buildings	1A4b	I.1.1, I.1.2	Residential
Commercial building and facilities	1A4a	I.2.1, I.2.2	Tertiary/commercial
Institutional buildings and facilities	1A4a		Municipal (incl. public lighting)
Industrial buildings and facilities	1A1, 1A2	I.3.1, I.3.2, I.4.1, I.4.2	Industry
Agriculture	1A4c	I.5.1, I.5.2	Agriculture/Forestry/Fisheries
Fugitive emissions	1B1, 1B2	I.7.1, I.8.1	Other emissions (incl. fugitive emissions)
Transportation			Final energy consumption in the 'transport' sector (several sub-sectors proposed, incl. municipal, public, private and commercial)
On-road	1A3b	II.1.1, II.1.2	Road*
Rail	1A3c	II.2.1, II.2.2	Rail*
Waterborne navigation	1A3d	II.3.1, II.3.2	Local and domestic waterways*
Aviation	1A3a	II.4.1, II.4.2	Local aviation*
Off-road	1A3e	II.5.1, II.5.2	Other/Off-road*
Waste			Other emission sources (not related to energy consumption)
Solid waste disposal	4A	III.1.1, III.1.2	Waste management Sub-sectors: solid waste, biological waste, incinerated and burned waste *
Biological treatment	4B	III.2.1, III.2.2	
Incineration and open burning	4C	III.3.1, III.3.2	
Wastewater	4D	III.4.1, III.4.2	Wastewater management
Industrial Process and Product Use (IPPU)			Final energy consumption in the 'industry' sector
Industrial Process	2A, 2B, 2C, 2E	IV.1.1	Industry
Product Use	2D, 2F, 2G, 2H	IV.2.1	
Agriculture, Forestry and Other Land Use (AFOLU)			Other emission sources (not related to energy consumption)
Livestock	3A	V.1.1	Agriculture, Forestry and Fisheries
Land use	3B	V.2.1	
Other AFOLU	3C, 3D	V.3.1	
Energy Generation			Energy Supply
Electricity-only generation	1A1	I.4.4	Electricity production (incl. certified green electricity, local electricity production)
CHP generation			
Heat/cold generation			Local heat/cold production
Local renewable generation			Renewable energy generation

Exercise: Transportation

Activity	Sub-sector
Diesel-powered freight train	
Rowing boat	
Electric bicycle	
Helicopter	
Tractor	
Rubbish truck	
Car ferry	
Bus rapid transit (BRT) running on diesel	

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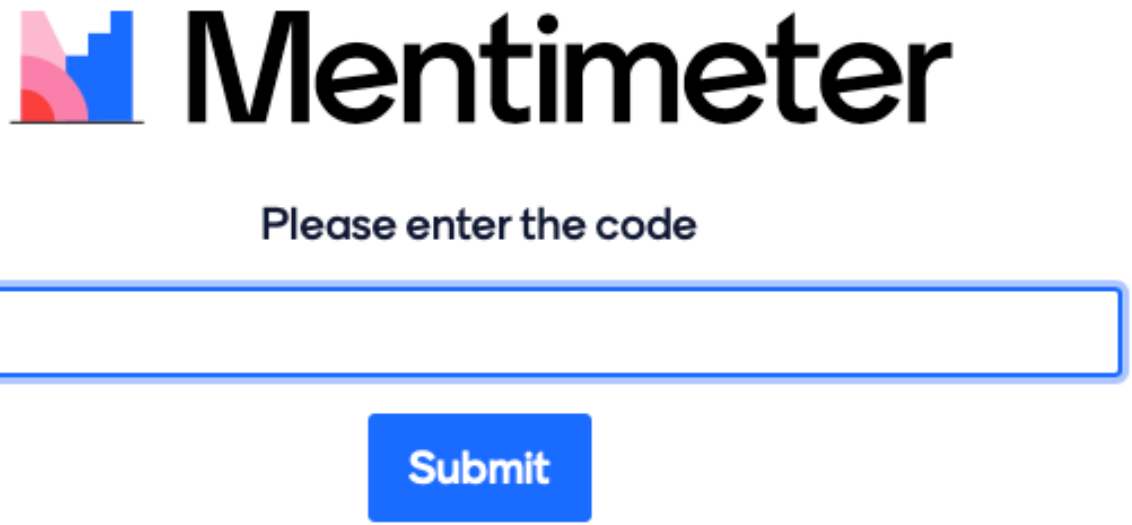


Exercise: Transportation

Activity	Sub-sector
Diesel-powered freight train	II.2.1
Rowing boat	-
Electric bicycle	II.1.2
Helicopter	II.4.1 or II.4.2
Tractor	II.5.1
Rubbish truck	II.1.1 or II.1.2
Car ferry	II.3.1
Bus rapid transit (BRT) running on diesel	II.1.1

Data needs

Sub-sector		Petrol / Gasoline	Diesel	CNG	Bio-diesel	Ethanol	Jet fuel	Electricity
II.1	On-road	Cars, taxis, rickshaws	✔	✔	✔	Cars, rickshaws		Cars, motorcycles
II.2	Railways		✔					✔
II.3	Waterborne navigation	✔	✔		✔			
II.4	Aviation						✔	
II.5	Off-road	?	?	?	?	?		?

Module D

Transportation

02

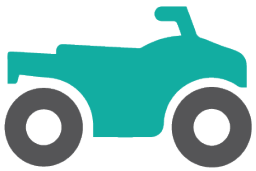
Transportation methodologies

Apportioning transportation emissions

Emission sources in the transportation sector are mobile by nature, apportioning these emissions by scope can therefore be challenging, and often requires looking into the available data for more information

City transit – via road, rail, water or air – can either be:

- wholly contained within the city boundary (**scope 1** and **scope 2**) or
- will cross city boundaries (**scope 3**). In this case, trips may originate or terminate in the city or simply pass through



II.1 On-road

This category includes vehicles such as buses, cars, trucks, motorcycles, on-road waste collection and transportation vehicles (e.g. compactor trucks), etc.

Most vehicles burn liquid (e.g. petrol / diesel) or gaseous fuel (e.g. LPG) in internal combustion engines. The combustion of these fuels produces CO_2, CH_4, and N_2O, often referred to collectively as tailpipe emissions.

Increasingly, electric or hybrid vehicles can also be charged at stations within or outside the city.

The methodology chosen for calculating on-road transportation emissions from fuel combustion will impact how **scope 1** and **scope 3** emissions are allocated for transboundary journeys.

To accommodate for differences in data availability, the GPC outlines **four methodologies** for apportioning emissions:

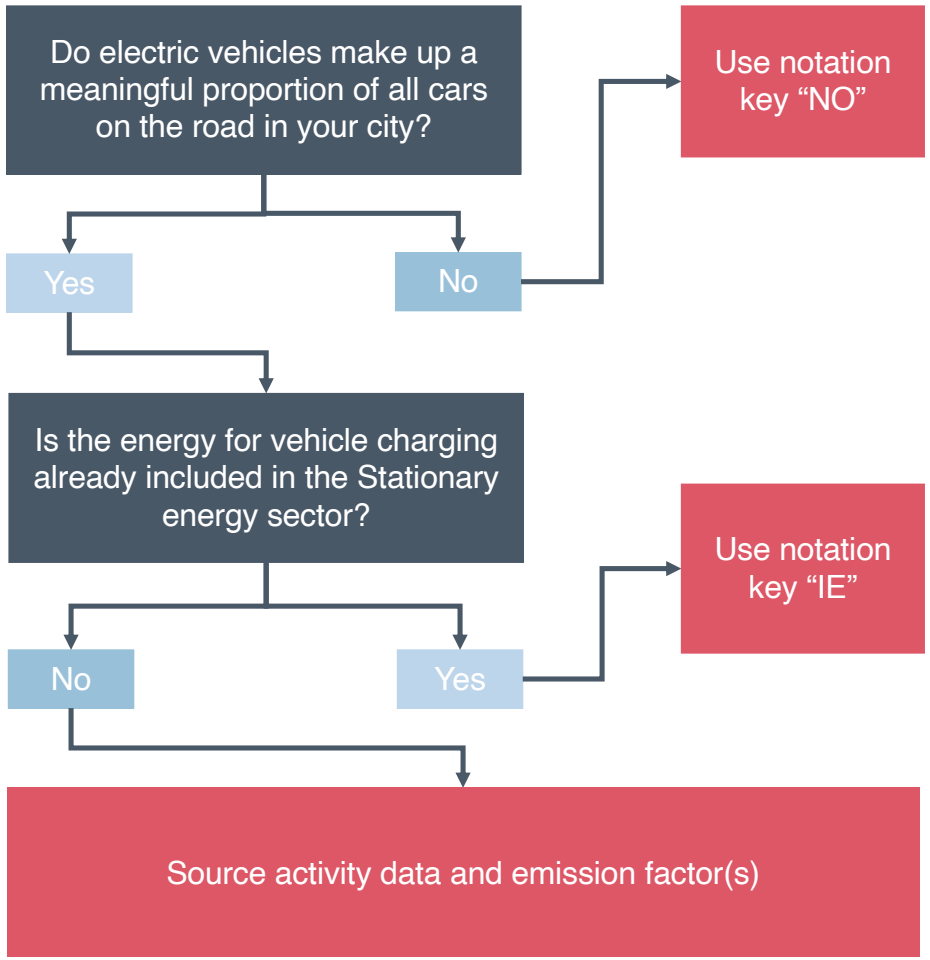
- Fuel sales
- Induced activity
- Geographic
- Residential activity

II.1 On-road

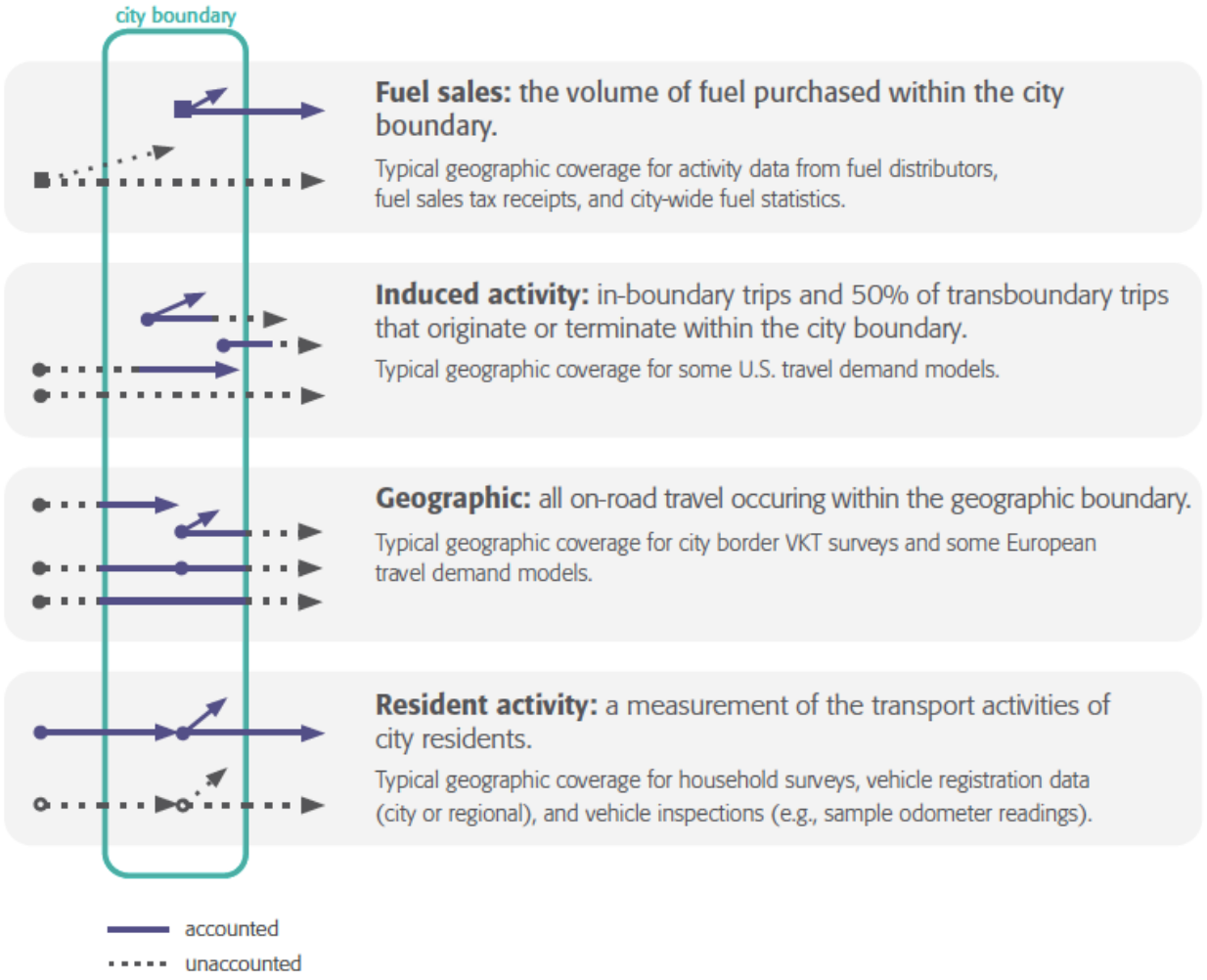
Scope 2 emissions should be calculated based on consumption at charging stations in the city boundary, regardless of the trip destination.

Charging stations might be at homes or workplaces that are already included in the Stationary Energy sector.

Cities should ensure that energy used for electric vehicle charging is separate from, and not double counted with, energy used in these other Stationary Energy sub-sectors.



Transportation methodologies



Fuel sales: the volume of fuel purchased within the city boundary.

Typical geographic coverage for activity data from fuel distributors, fuel sales tax receipts, and city-wide fuel statistics.

Induced activity: in-boundary trips and 50% of transboundary trips that originate or terminate within the city boundary.

Typical geographic coverage for some U.S. travel demand models.

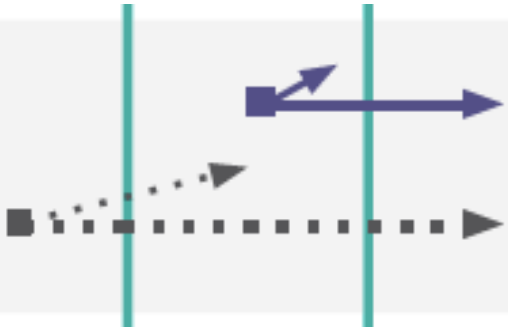
Geographic: all on-road travel occuring within the geographic boundary.

Typical geographic coverage for city border VKT surveys and some European travel demand models.

Resident activity: a measurement of the transport activities of city residents.

Typical geographic coverage for household surveys, vehicle registration data (city or regional), and vehicle inspections (e.g., sample odometer readings).

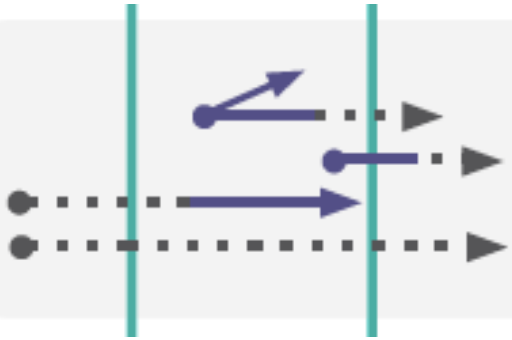
Fuel sales



Fuel sales: the volume of fuel purchased within the city boundary.

Typical geographic coverage for activity data from fuel distributors, fuel sales tax receipts, and city-wide fuel statistics.

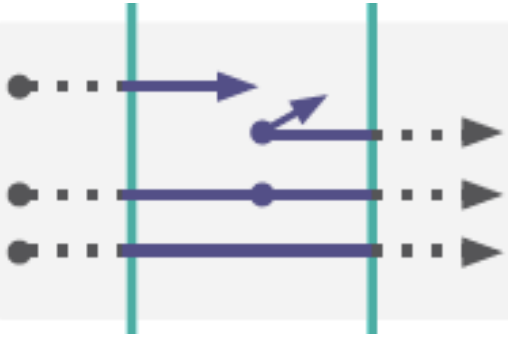
Induced activity



Induced activity: in-boundary trips and 50% of transboundary trips that originate or terminate within the city boundary.

Typical geographic coverage for some U.S. travel demand models.

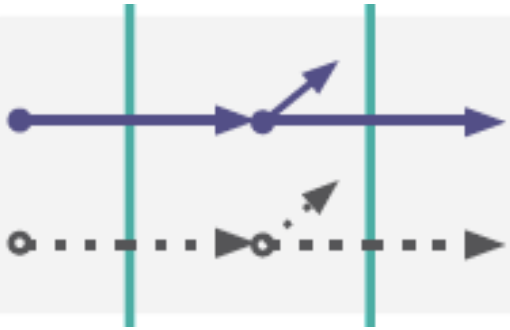
Geographic



Geographic: all on-road travel occuring within the geographic boundary.

Typical geographic coverage for city border VKT surveys and some European travel demand models.

Resident activity



Resident activity: a measurement of the transport activities of city residents.

Typical geographic coverage for household surveys, vehicle registration data (city or regional), and vehicle inspections (e.g., sample odometer readings).

Transportation methodologies

Methodology		Advantages	Disadvantages
Fuel sales		• More consistent with national inventory practices • Less costly and time-consuming • Do not require high level of technical capacity • Well suited to aggregation with other city's data	• Does not capture all on-road travel • Does not provide information on modal share or vehicle type • Does not allow for allocating emissions by scope
Vehicle kilometers travelled (VKT) and model-based	Induced activity	• Can produce detailed and more useful data for transportation planning • Integrates better with existing city transport models and planning processes	• More expensive, time consuming, and less comparable between cities due to variation in models used
	Geographic		
	Resident activity		

Transportation methodologies

Methodology	Allocation	Scope 1	Scope 2	Scope 3
Fuel sales	Not applicable unless additional steps taken	All emissions from fuel sold within the boundary	Any electric charging station in the city boundary	Not applicable unless fuel sales allocated to scope 1 and 3 by specified method
City-induced activity (e.g. US demand models)	Origin-Destination	In-boundary trips and in-boundary portion of 50% of transboundary trips (pass through trips excluded)		Out-of-boundary portion of 50% of transboundary trip
		In-boundary trips and in-boundary portion of all departing trans-boundary trips (pass-through trips excluded)		Out-of-boundary portion of all departing transboundary trips
Geographic / Territorial (e.g. European demand models)	Not applicable	All traffic occurring within city boundaries, regardless of origin or destination		Not applicable unless additional steps taken
Resident activity	Options	Either resident activity is all scope 1, or use origin-destination		N/A or origin-destination used

Exercise: Transportation methodologies

Description	Methodology
Transport activities only by those who live in the city	Fuel sales
All traffic occurring within the city boundary	City-induced
Volume of fuel purchased within the city	Geographic
All trips within the city and half of the trips that either start or end in the city	Resident

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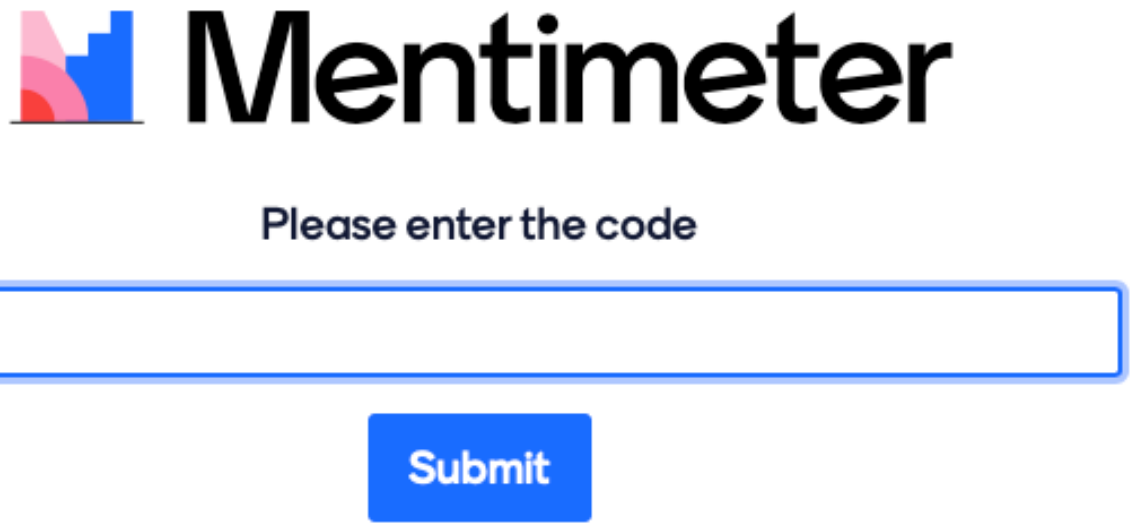
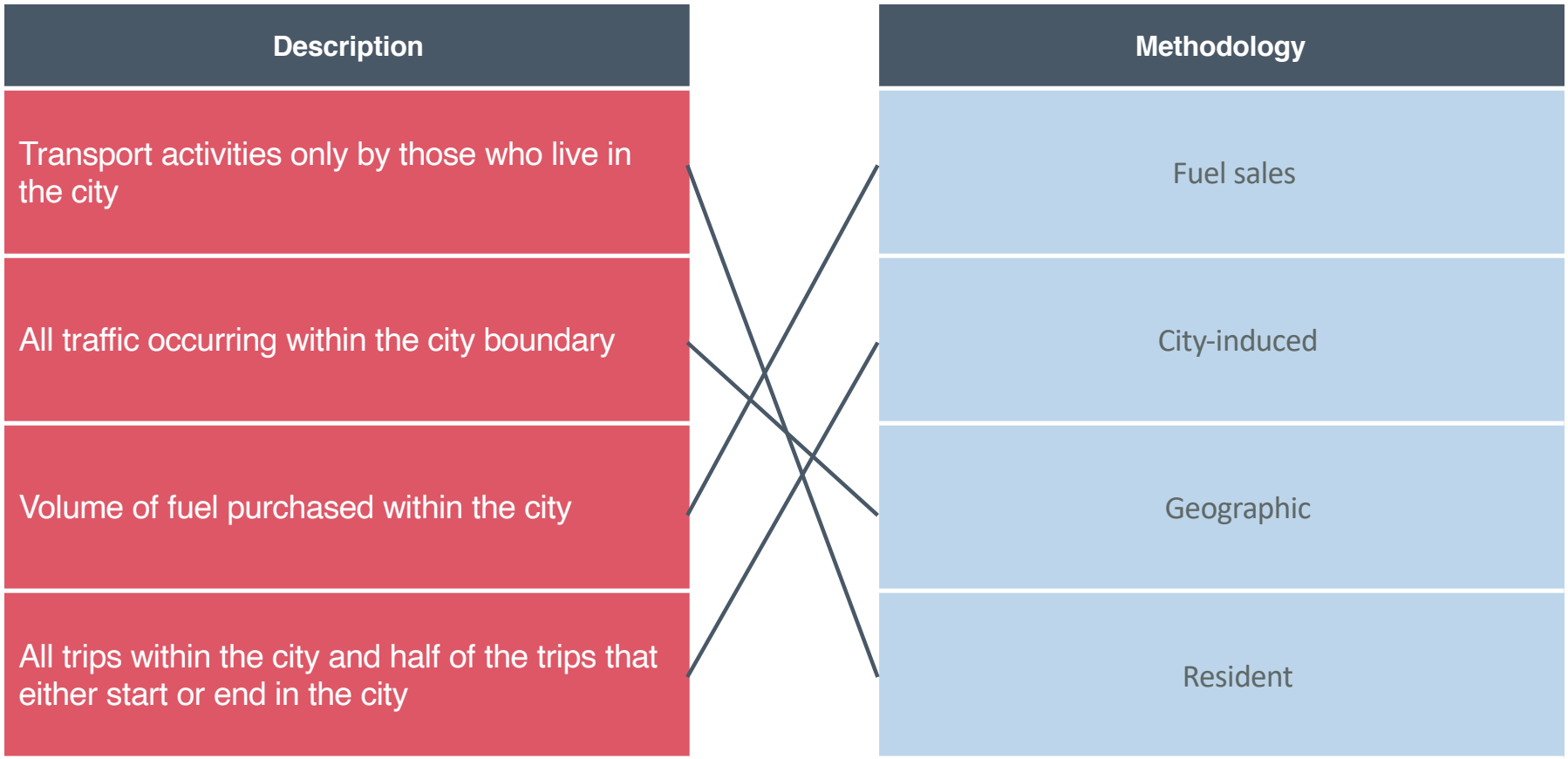
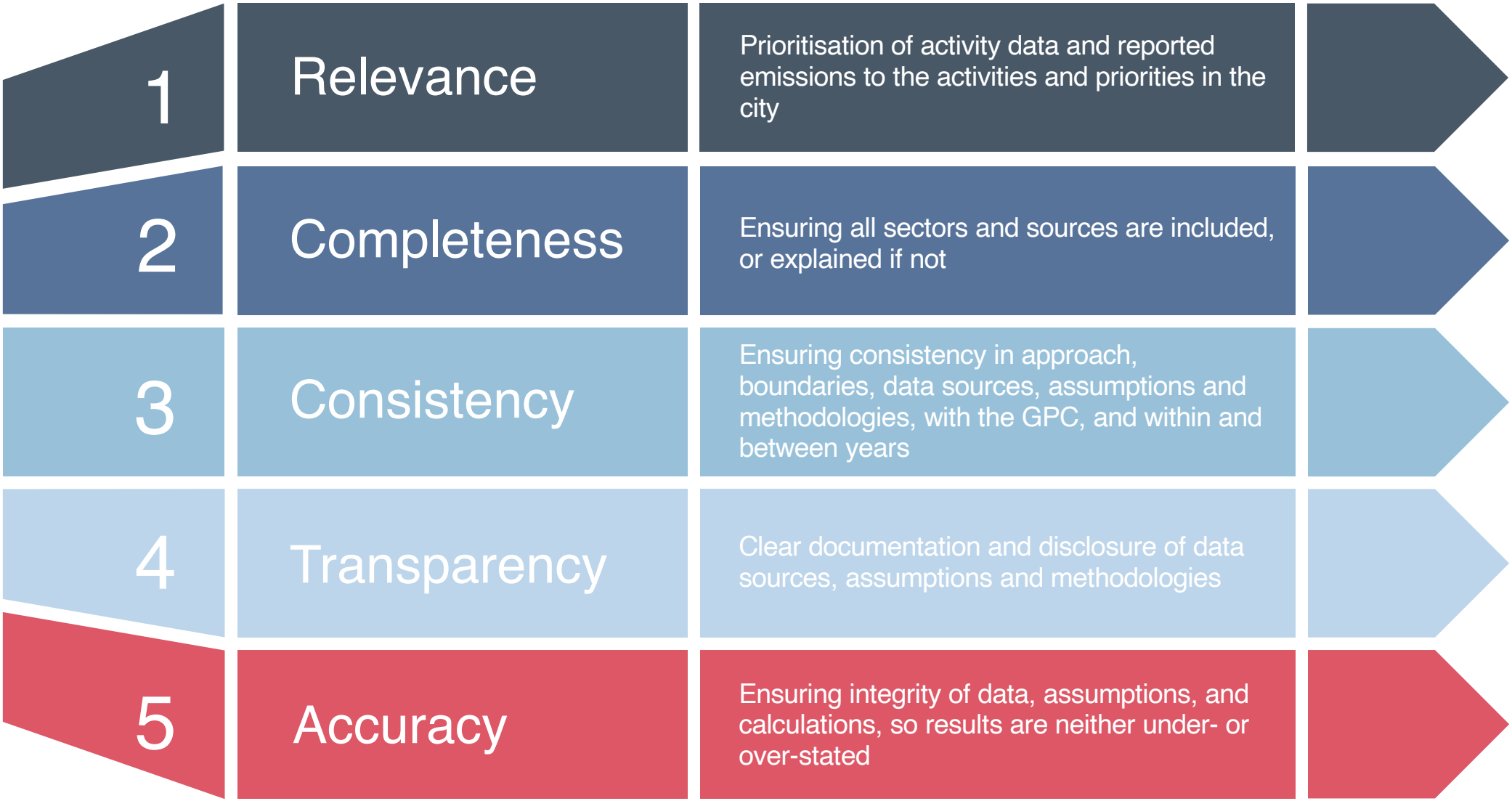


Exercise: Transportation methodologies



Exercise: Transportation methodologies

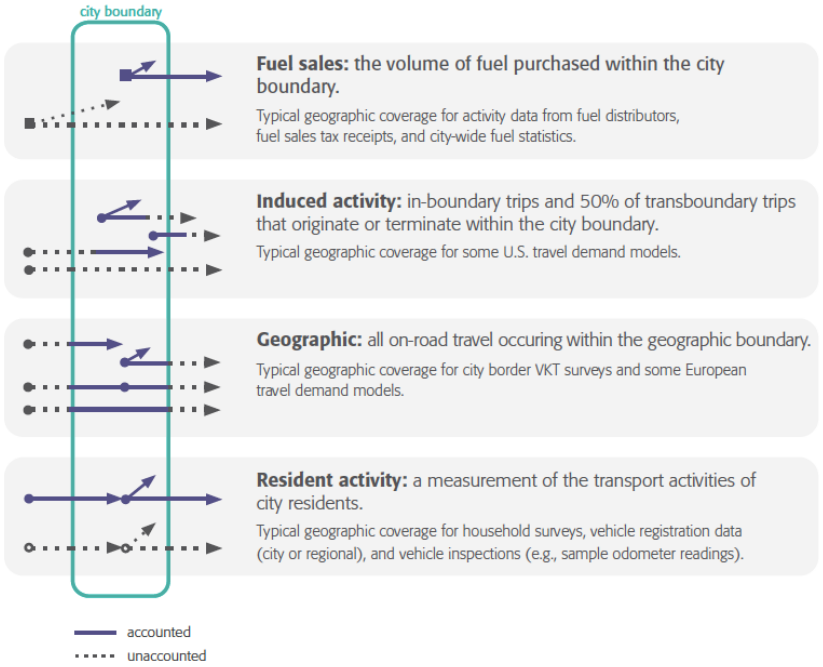
Accounting and reporting principle	Preferred transportation methodology
Relevance	
Completeness	
Consistency	
Transparency	
Accuracy	
City	


1
Relevance
Prioritisation of activity data and reported emissions to the activities and priorities in the city
2
Completeness
Ensuring all sectors and sources are included, or explained if not
3
Consistency
Ensuring consistency in approach, boundaries, data sources, assumptions and methodologies, with the GPC, and within and between years
4
Transparency
Clear documentation and disclosure of data sources, assumptions and methodologies
5
Accuracy
Ensuring integrity of data, assumptions, and calculations, so results are neither under- or over-stated

Exercise: Transportation methodologies

Accounting and reporting principle	
Relevance	*Prioritisation of activity data and reported emissions to the activities and priorities in the city*
Completeness	*Ensuring all sectors and sources are included, or explained if not*
Consistency	*Ensuring consistency in approach, boundaries, data sources, assumptions and methodologies*
Transparency	*Clear documentation and disclosure of data sources, assumptions and methodologies*
Accuracy	*Ensuring integrity of data, assumptions, and calculations, so results are neither under- or over-stated*
City	

Preferred transportation methodology



Transportation methodologies

Accounting and reporting principle	Preferred transportation methodology
Relevance	
Completeness	
Consistency	
Transparency	
Accuracy	
City	

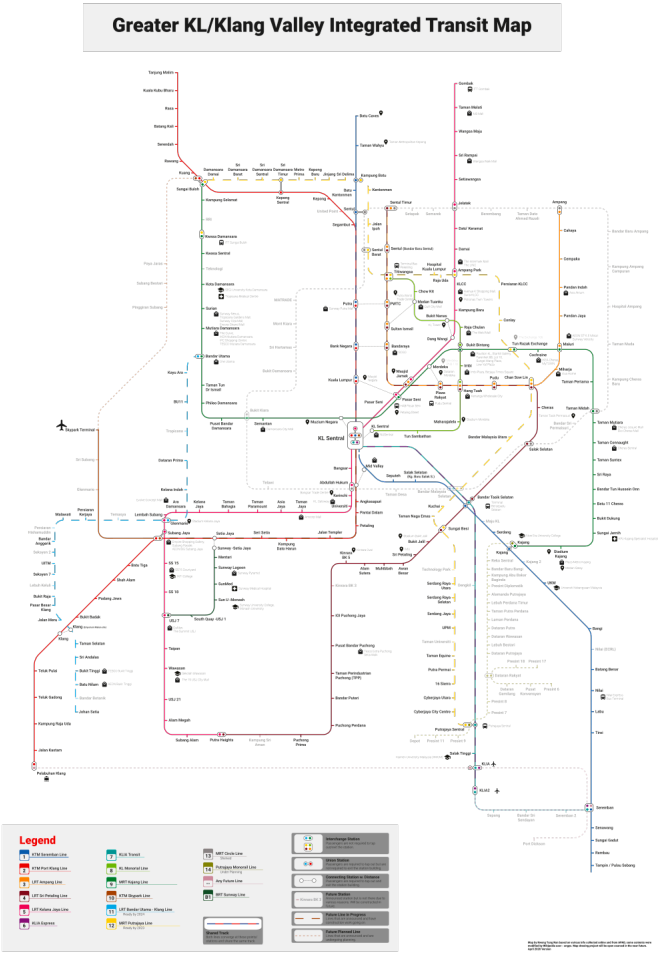
II.2 Railway

Railways can be used to transport people and goods, and are powered by a locomotive, which typically uses energy through combustion of diesel fuels or electricity (known as electric traction)*

Railway type	Example
Urban train / subway	Rapid KL
Regional commuter rail	Ekspres Rail Link
National rail	ETS
International rail	KTM West Coast Line

Each can be further classified as passenger or freight

* Railways can also use natural gas or coal, or include CNG or biofuels



Source: Wikipedia

II.2 Railway

Scope 1 emissions include emissions from direct combustion of fossil fuels incurred during the length of railway transit within the city boundary for railway lines that have stops in the city boundary.

All electricity charged for railway vehicle travel within the city boundary shall be accounted for under **scope 2** emissions.

Cities should obtain fuel consumption data by fuel types and application (e.g., transit system, freight, etc.) for the distance covered within the city boundary (scope 1 and 2) and the lines' extension outside the city (**scope 3**).

Cities may either include or omit emissions from pass-through rail trips that do not stop in the city boundary.

Steps
Identify all types of rail travel in the city: urban, regional / commuter, national and international
Allocate these as either inboundary or transboundary
For inboundary rail travel, allocate all emissions to scope 1 or 2
For transboundary rail travel, decide how you will apportion these to your city: % stops, % passengers, % GDP, % freight
Next, source activity data (e.g. fuel used, distance travelled) and emission factors

II.2 Railway

Activity data * Adjustment * Emission factor = GHG

Activity data

- Fuel use (litres of diesel; kWh of electricity)
- Distance travelled (passenger km; tonne km)

Adjustment (for transboundary journeys)

- e.g. 50%
- Scaling factor

Emission factor

- kgCO2e/litre; kgCO2e/kWh
- kgCO2e/passenger-km; kgCO2e/tonne-km

Source activity data and emission factor(s)
Contact railway companies
Local, state, or national statistics or transportation agencies
Estimate distance travelled using schedule information and fuel economy data
Scale regional / national data down using population or GDP per capita

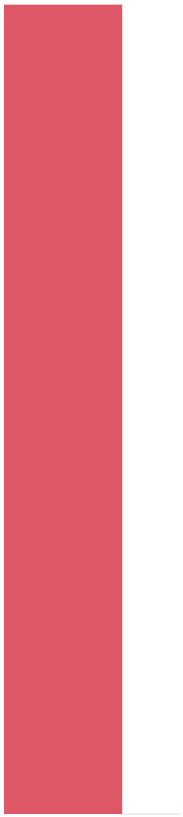
Biennial Update Report #3

Table 1.15: Key Statistics for 2005 and 2016

Year	2005	2016
Latitude	0º 51´ N - 7º 33´ N	
Longitude	98º 01´ E – 1 9º 30´ E	
Area	330,345 km^2	
Coastline	8,840 km	
Mean daily temperature	26 – 28 ºC	
Average annual rainfall	2,000 – 4,000 mm	
Average daily direct sunlight	6 hours	
Forest Cover as % of total land area	53.9% (estimate)	55.5% (estimate)
Population	26.0 million	31.6 million
Population density	79 per km^2	96 per km^2
Female life expectancy	76.0 years	77.0 years
Male life expectancy	71.4 years	72.1 years
Age Profile	Below 15 years old – 30.9% 15 to 64 years old – 64.6% Above 65 years old – 4.5%	Below 15 years old – 24.5% 15 to 64 years old – 69.5% Above 65 years old – 6.0%
Urbanisation Rate	66.5%	74.8%
GDP (at 2010 constant prices)	RM 659,639 million	RM 1,108,900 million
GNI/capita (at 2010 constant prices)	RM 24,739	RM 37,822
Primary Energy Supply	66,211 ktoe	93,396 ktoe
Final Energy Demand	38,284 ktoe	57,218 ktoe
Total Electricity Consumption	73,987 GWh	116,529 GWh
Length of roads (Federal and State)	88,528 km	236,802 km
Motor vehicle registration	14,816,407	27,613,259
Annual Ridership on urban rail network in Greater Kuala Lumpur/ Klang Valley (passenger journeys)	157,475,402	210,498,247
Public transport modal share in Greater Kuala Lumpur/ Klang Valley	-	20%
Annual ridership on Stages Buses (11 towns and cities) (passenger journeys)	-	46,915
Solid Waste	-	33,130 tonnes/day (2012)

Source: BUR3

Railway: scaling transboundary travel



Buenos Aires

% of stops

Sydney

% GDP

Melbourne

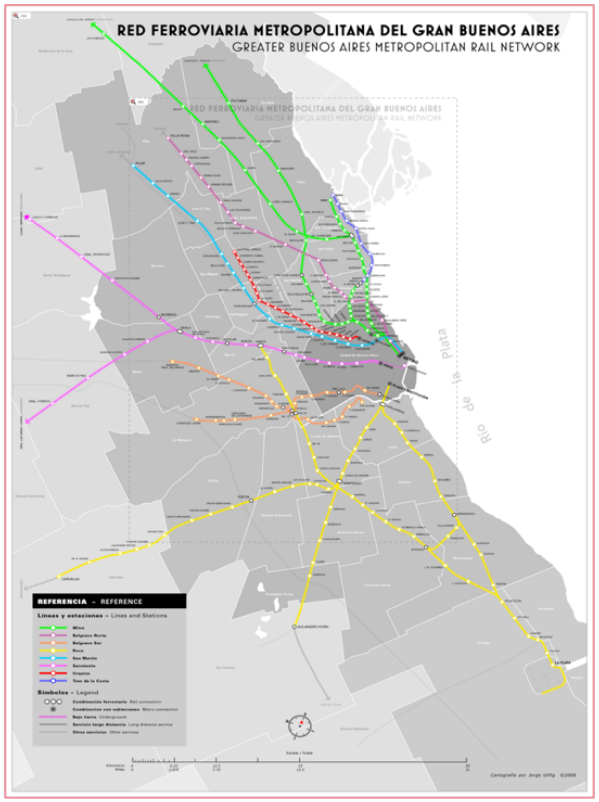
% distance travelled

Buenos Aires train network

- 7 lines (with different railway branches)
- 815 km line extension
- 305 stations
- 1,000 million passenger per year
- Serves metropolitan area

Calculation:

- Obtain total energy consumption in kWh
- Determine # of inboundary stops
- Allocate energy use according to **% of inboundary stops**



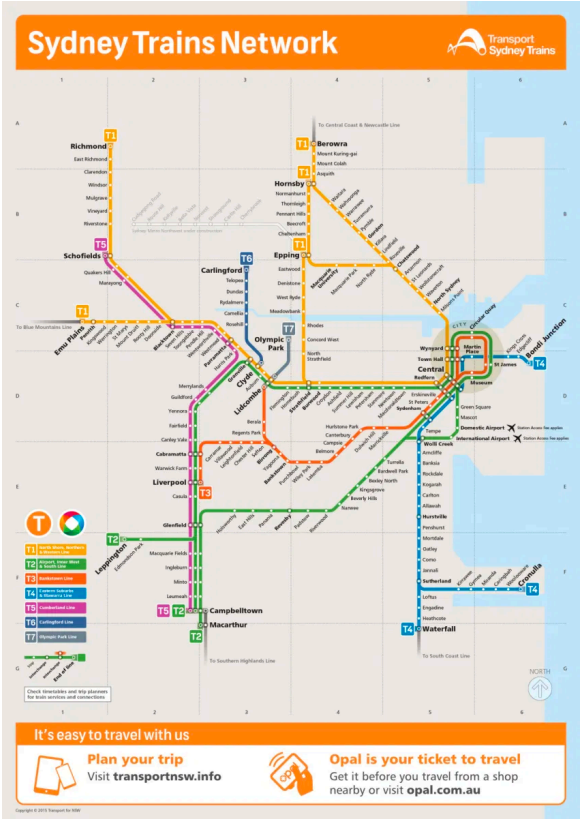
Source: Wikipedia

Sydney trains

- 8 lines
- 178 stations
- 248 million trips per year
- Operator: Sydney trains
- Serves metropolitan area

Calculation:

- Obtain total energy consumption in kWh
- Obtain GDP of city and metropolitan area
- Allocate energy use according to **% GDP**



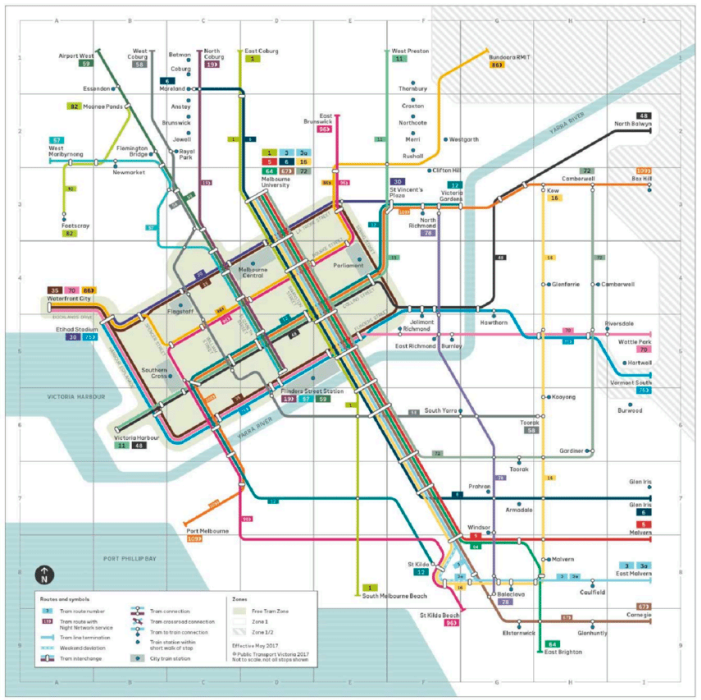
Source: Transport Sydney Trains

Melbourne tramway network

- 25 routes
- 1763 stops
- 173 million trips per year
- Operator: Yarra trams
- Serves metropolitan area

Calculation:

- Obtain total energy consumption in kWh
- Determine total distance travelled in city and metropolitan area
- Allocate energy use according to **% distance travelled**

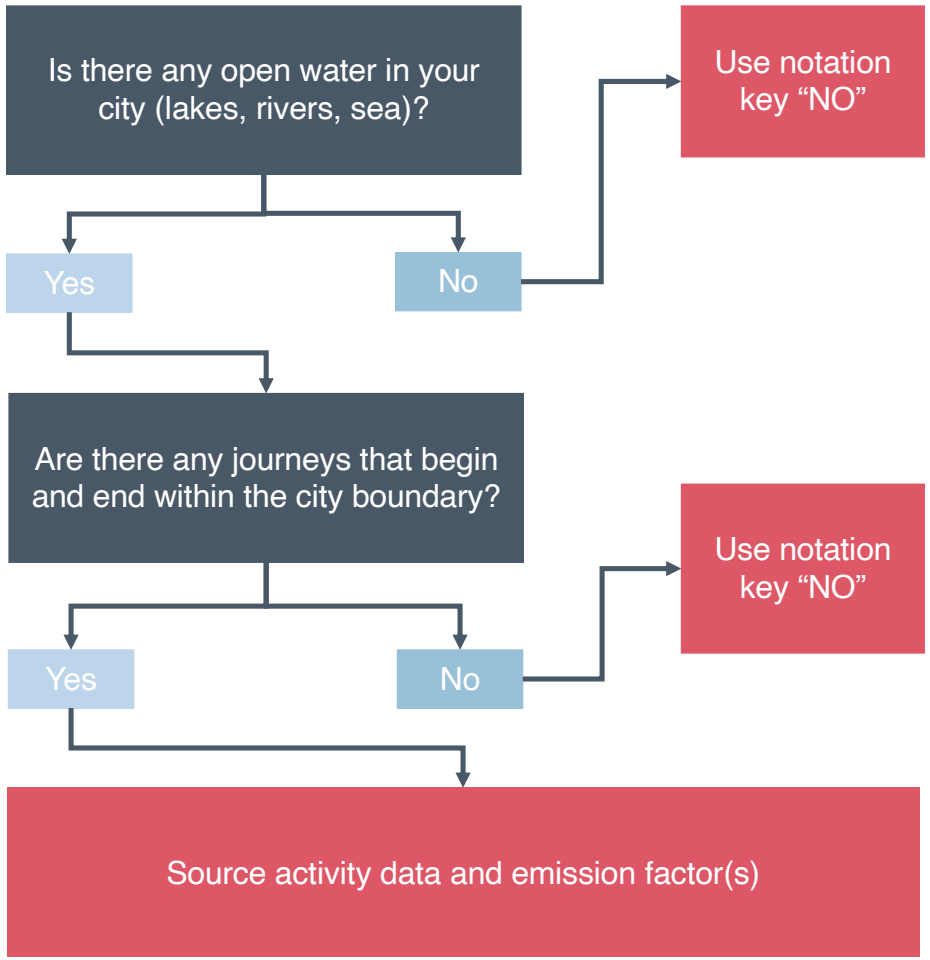


Source: https://www.researchgate.net/figure/Melbourne-tram-network_fig1_320142602

II.3 Waterborne navigation

Water transportation includes:

- Ships, ferries, and other boats operating within the city boundary (**scope 1**)
- Any grid-supplied energy that marine-vessels purchase and consume, typically at docks, ports or harbours (**scope 2**)
- Marine-vessels whose journeys begin or end at ports within the city's boundary but travel to destinations outside of the city (scope 3)

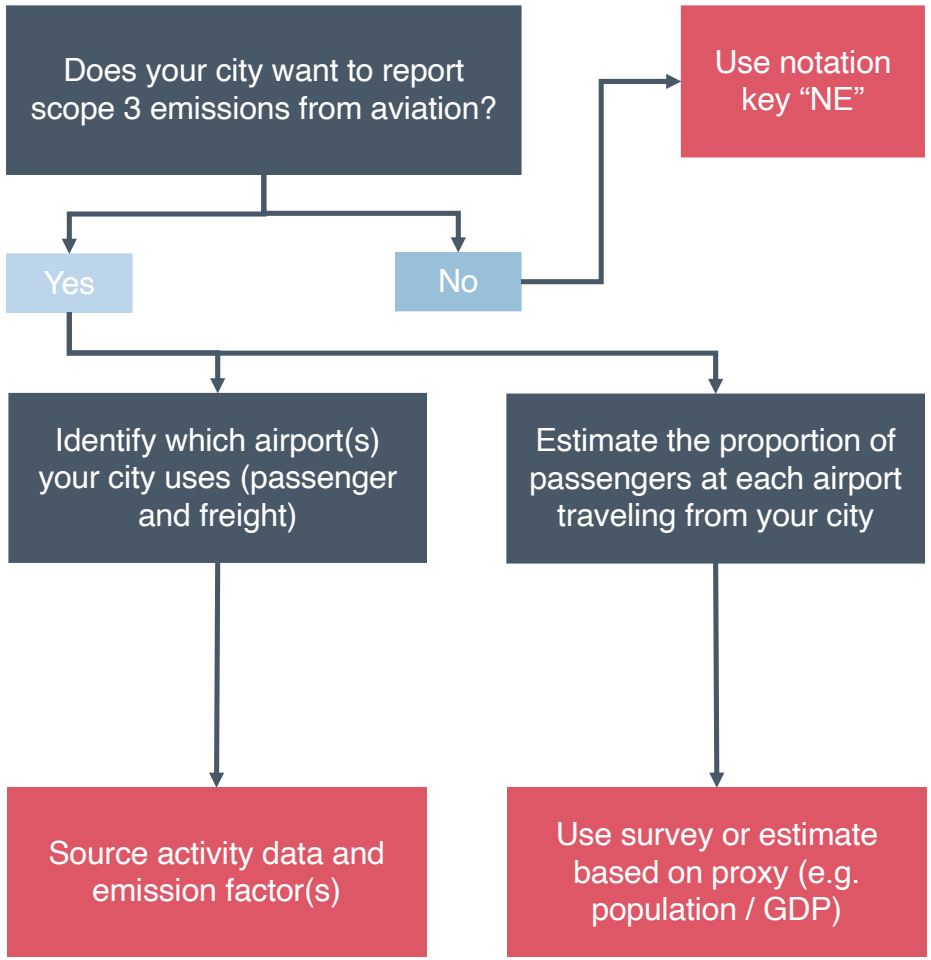


II.3 Waterborne navigation

While water transportation can be a significant source of emissions globally, most emissions occur during oceanic journeys outside of the boundaries of a port city.

IPCC Guidelines allow for exclusion of international waterborne navigation and air travel, but these journeys and their associated emissions can be useful for a city to understand the full impact of the transit connecting through the city.

In this case, **scope 3** covers emissions from departing transboundary trips powered by direct fuel combustion, apportioned to cover those departing trips that are attributable to the city.



II.3 Waterborne navigation

Activity data * Adjustment * Emission factor = GHG

Activity data

- Fuel use (litres of diesel)
- Distance travelled (km) (route length * number of trips)

Adjustment (for transboundary journeys)

- e.g. 50%
- Scaling factor

Emission factor

- kgCO2e/litre
- kgCO2e/km

Source activity data and emission factor(s)
Obtain fuel sales estimates of fuel loaded onto marine vessels from port / marine authorities and/or shipping companies
Local, state, or national statistics or transportation agencies
Use ferry schedules to calculate distances travelled and use use fuel economy figures for boats to estimate fuel use
Scale national level data down using appropriate scaling factors - National marine navigation data may be found through national maritime (marine) administration agencies.

Biennial Update Report #3

Table B3: Energy Sectoral Table for GHG Inventory Year 2016 (2 of 5)

Categories		CO_2	CH_4	N_2O	NO_x	CO	NMVOCs	SO_2
		(Gg)						
1A3a	Civil Aviation	1,132.99	0.01	0.03	4.85	2.10	0.10	0.47
1A3ai	International Aviation (International Bunkers)							
1A3aii	Domestic Aviation	1,132.99	0.01	0.03	4.85	2.10	0.10	0.47
1A3b	Road Transportation	55,188.34	20.06	2.67	513.35	4,671.56	878.03	0.00
1A3bi	Cars	IE	IE	IE	IE	IE	IE	IE
1A3bi1	Passenger cars with 3-way catalysts	IE	IE	IE	IE	IE	IE	IE
1A3bi2	Passenger cars without 3-way catalysts	IE	IE	IE	IE	IE	IE	IE
1A3bii	Light-duty trucks	IE	IE	IE	IE	IE	IE	IE
1A3bii1	Light-duty trucks with 3-way catalysts	IE	IE	IE	IE	IE	IE	IE
1A3bii2	Light-duty trucks without 3-way catalysts	IE	IE	IE	IE	IE	IE	IE
1A3biii	Heavy-duty trucks and buses	IE	IE	IE	IE	IE	IE	IE
1A3biv	Motorcycles	IE	IE	IE	IE	IE	IE	IE
1A3bv	Evaporative emissions from vehicles				NE	NE	NE	NE
1A3bvi	Urea-based catalysts	NO			NO	NO	NO	NO
1A3c	Railways	77.73	0.00	0.03	1.31	0.27	0.12	NA
1A3d	Water-borne Navigation	5,505.04	0.52	0.15	139.35	13.14	4.97	35.50
1A3di	International water-borne navigation (International bunkers)							
1A3dii	Domestic Water-borne Navigation	5,505.04	0.52	0.15	139.35	13.14	4.97	35.50
1A3e	Other Transportation	NE	NE	NE	NE	NE	NE	NE
1A3ei	Pipeline Transport	NE	NE	NE	NE	NE	NE	NE
1A3eii	Off-road	NE	NE	NE	NE	NE	NE	NE
1A4	**Other Sectors**	5,318.944	0.514	0.019	21.59	4.10	1.01	3.63
1A4a	Commercial/Institutional	2,576.30	0.23	0.01	19.90	2.60	0.97	1.82
1A4b	Residential	1,600.71	0.13	0.00	1.29	1.44	0.02	1.77
1A4c	Agriculture/Forestry/Fishing/Fish Farms	1,141.927	0.154	0.009	0.40	0.05	0.02	0.04
1A4ci	Stationary	57.236	0.008	0.000	0.40	0.05	0.02	0.04

Source: BUR3

II.4 Aviation

Air travel includes emissions from airborne trips occurring within the geographic boundary (e.g. helicopters, **scope 1**) and emissions from flights departing airports that serve the city (**scope 3**).

A significant amount of emissions associated with air travel occur outside the city boundary. Airports located within a city typically service the greater region in which the city exists. These complexities make it challenging to properly account for, and attribute, aviation emissions.

Cities should also disaggregate data between local (scope 1), domestic and international flights, and where possible passenger and freight flights.

.

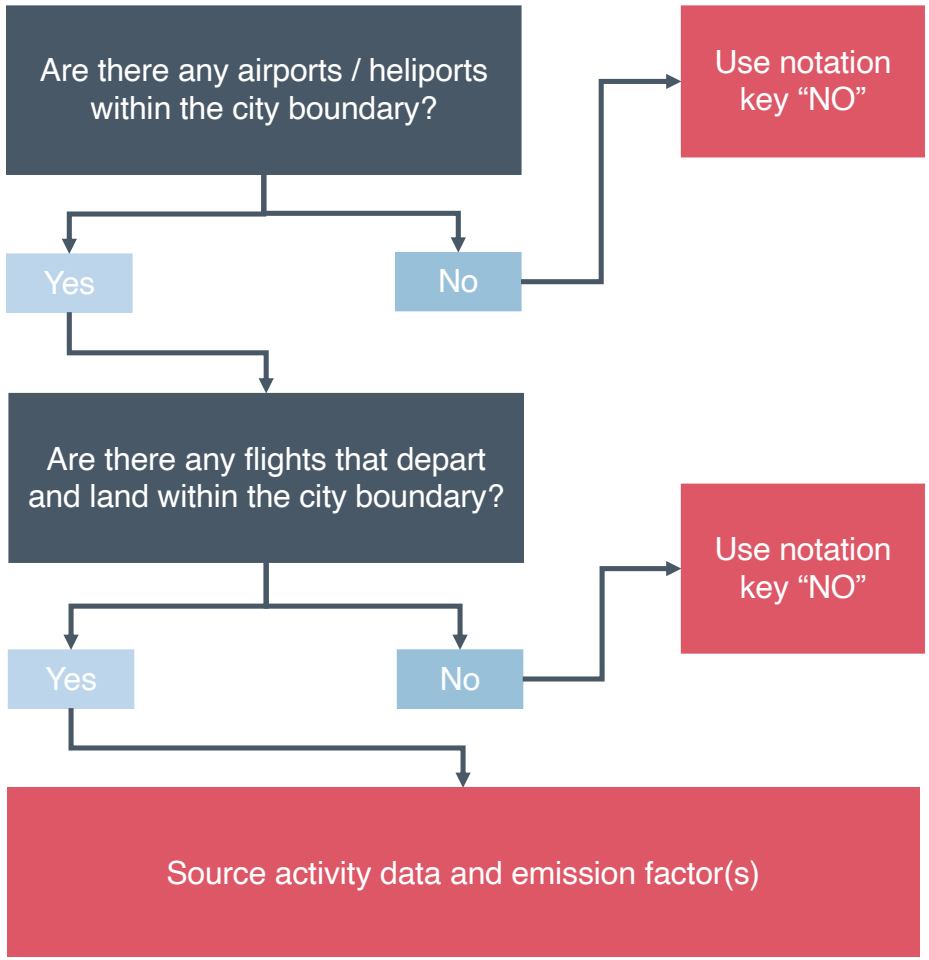
Flight classification	Flight type
Local	Passenger
National (domestic)	Passenger / Freight
International	

Source: Wikipedia

II.4 Aviation

Scope 1 includes emissions from the direct combustion of fuel for all aviation trips that depart and land within the city boundary (e.g. local helicopter, light aircraft, sightseeing and training flights).

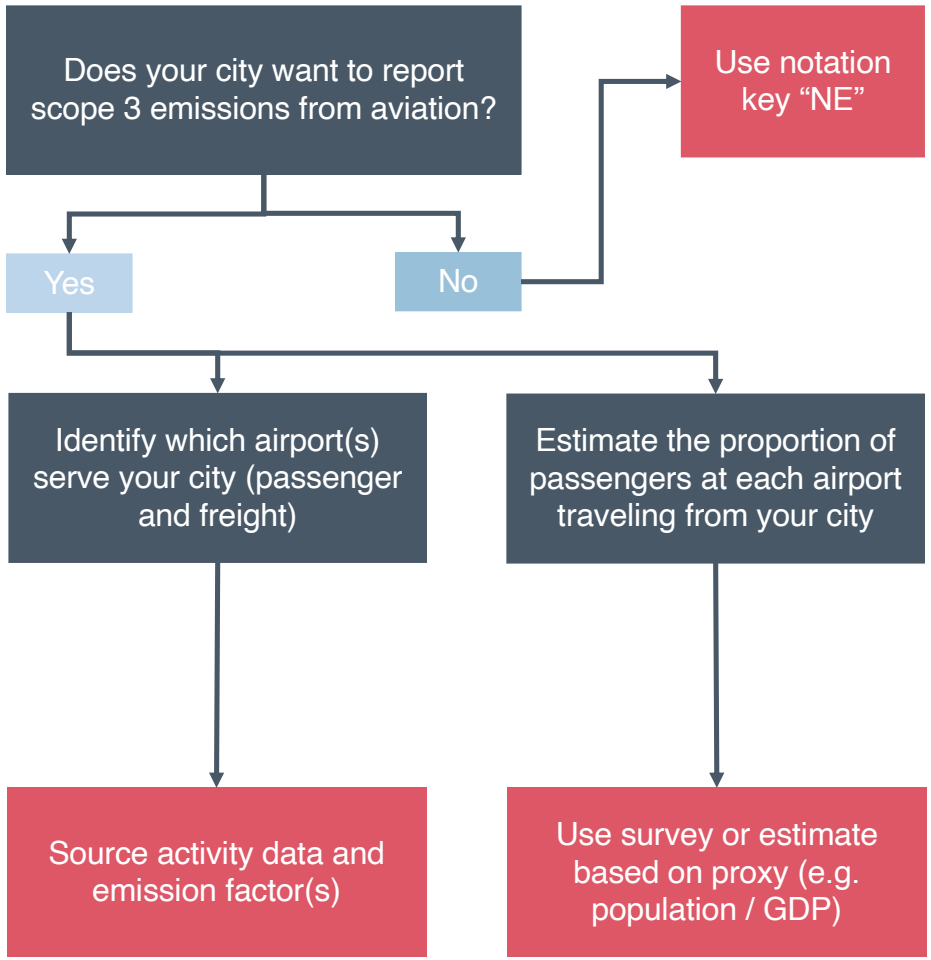
Scope 2 includes any grid-supplied energy consumed by aircraft charging at airports. Any grid-supplied energy consumed at airport facilities should be included in I.2.2.



II.4 Aviation

Scope 3 includes emissions from **departing** flights at airports that serve the city, whether the airport is located within the geographic boundary or outside of it.

The city may report just the emissions from departing flights that are attributable to the city by estimating the proportion of passengers traveling from the city. This is in line with the origin and destination model described with the induced activity method.



II.4 Aviation

Activity data * Adjustment * Emission factor = GHG

Activity data

- Fuel use (tonnes or litres of jet fuel)
- Distance travelled (km; passenger km; tonne km)

Adjustment (for domestic and international trips)

- Survey to determine % of trips attributable to city
- Scaling factor

Emission factor

- $kgCO_2e$/tonne; $kgCO_2e$/litre
- $kgCO_2e$/km
- $kgCO_2e$/passenger-km; $kgCO_2e$/tonne-km

Source activity data and emission factor(s)
Contact heliports / airports for fuel use data
Contact local helicopter companies / airlines for fuel use data
Local, state, or national statistics or transportation agencies
Estimate using schedule information and fuel economy data
Scale national data down using population or GDP per capita

II.4 Aviation

Example: Emission factors for air travel (UK)

Activity	Haul	Class	Unit	kg CO_2e	kg CO_2	kg CH_4	kg N_2O
Flights	Domestic, to/from UK	Average passenger	passenger.km	0,13483	0,13345	0,00012	0,00126
	Short-haul, to/from UK	Average passenger	passenger.km	0,0837	0,08291	0,00001	0,00078
		Economy class	passenger.km	0,08233	0,08155	0,00001	0,00077
		Business class	passenger.km	0,1235	0,12233	0,00001	0,00116
	Long-haul, to/from UK	Average passenger	passenger.km	0,10342	0,10244	0,00001	0,00097
		Economy class	passenger.km	0,0792	0,07845	0,00001	0,00074
		Premium economy class	passenger.km	0,12673	0,12553	0,00001	0,00119
		Business class	passenger.km	0,22969	0,22752	0,00002	0,00215
		First class	passenger.km	0,31681	0,31382	0,00002	0,00297
	International, to/from non-UK	Average passenger	passenger.km	0,09558	0,09467	0,00001	0,0009
		Economy class	passenger.km	0,073195	0,0725	0,000005	0,00069
		Premium economy class	passenger.km	0,11711	0,116	0,00001	0,0011
		Business class	passenger.km	0,21226	0,21025	0,00002	0,00199
		First class	passenger.km	0,29276	0,29	0,00002	0,00274

Source: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2019

II.5 Off-road

Off-road vehicles are those designed or adapted for travel on unpaved terrain. This category typically includes all-terrain vehicles, landscaping and construction equipment, tractors, bulldozers, amphibious vehicles, snowmobiles and other off-road recreational vehicles. For the purposes of the GPC, only **scope 1 and scope 2** emissions are included.

Cities should only report under the off-road **transportation** sub-sector emissions from off-road transportation activities within transportation facility premises such as airports, harbours, bus terminals, and train stations.

Other off-road transportation activities within industrial premises and construction sites, farms, forests and military premises, are reported under **Stationary Energy**.

Comprehensive top-down activity data on off-road vehicles are often unavailable, and alternative methods are typically necessary to estimate emissions within this category:

- Assume off-road activities are negligible and use notation key “NO” for scope 1 and scope 3 (use “NE” for scope 3)
- If using fuel sales approach, assume off-road activities are included in II.1 and use notation key “IE”
- Conduct a survey and scale up for the city
- Use national – or regional – off-road modelling software
- Scale national off-road mobile fuel consumption down according to population share

II.5 Off-road

Type of off-road activities	Reporting guidance
Off-road vehicle and mobile machinery within industrial premises and construction sites	Report as a **Stationary Energy** source under manufacturing industries and construction sub-sector or energy industries subsector as appropriate
Off-road vehicle and mobile machinery within agriculture farms, forests, and aquaculture farms	Report as a **Stationary Energy** source under agriculture, forestry, and fishing activities sub-sector
Off-road vehicle and mobile machinery within the transportation facility premises such as airports, harbours, bus terminals, and train stations	Report as a **Transportation** source under off-road transportation sub-sector
Off-road vehicle and mobile machinery within military premises	Report as a **Stationary Energy** source under unidentified activities sub-sector

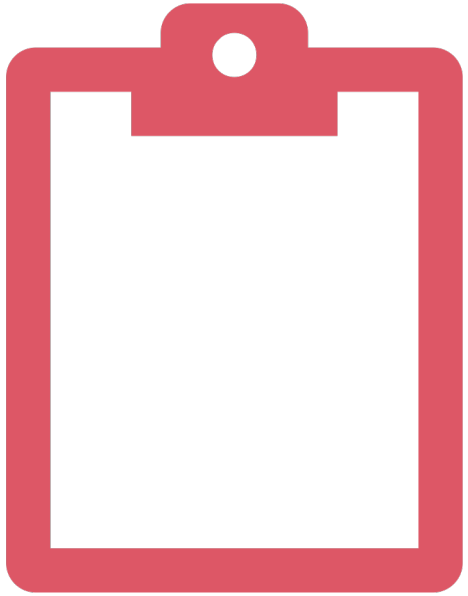
Module D

Transportation

03

Practical

Practical



Practical

	Task	
1	Identify all sources of GHG emissions from energy use in transportation : • What activities (modes) are taking place? Consider both passenger and freight travel • Where are the emissions occurring? In boundary vs out of boundary. List them in Table 1	20m
2	Determine what types of fuel are being used. Complete Table 2	
3	Use the fuel sales methodology to estimate scope 1 emissions from on-road transportation	15m
4	Use the induced activity methodology to estimate scope 2 emissions from railways	15m
5	Record your data in Table 3, clearly documenting methodologies and data sources used. For now, assume no scope 1 emissions from waterborne navigation and aviation. Where no GHG emissions occur or are deemed insignificant, use “NO”. For scope 3 sources, use “NE”.	HW
6	Consolidate the above information into Table 4 and identify what activity data and emission factors you will need to estimate GHG emissions for Transportation, including different subsectors (GPC) and journey types (CRF), and where you will source this from	HW

HW = home work

Practical

	Task	
1	Identify all sources of GHG emissions from energy use in transportation : • What activities (modes) are taking place? Consider both passenger and freight travel • Where are the emissions occurring? In boundary vs out of boundary. List them in Table 1	20m
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Workbook: Task #1

GTALCC GHG Accounting - Participant handbook

Exercises	
Module B	Calculating GHG emissions
	Reviewing an inventory
Module C	Stationary energy
Module D	Transportation
Module E	Waste
Module F	IPPU and AFOLU

Tables	
Table 1	GHG emission sources
Table 2	Fuel types
Table 3	GPC
Table 4	Action plan

Reference
GPC
GWP
Notation keys
Checklist

Table 1: GHG emission sources

Sub-sector		Sources of GHG emissions
II.1	On-road	
II.2	Railways	
II.3	Waterborne navigation	
II.4	Aviation	
II.5	Off-road	

Practical

	Task	
1	Identify all sources of GHG emissions from energy use in transportation : • What activities (modes) are taking place? Consider both passenger and freight travel • Where are the emissions occurring? In boundary vs out of boundary. List them in Table 1	20m
2	Determine what types of fuel are being used. Complete Table 2	
3	Use the fuel sales methodology to estimate scope 1 emissions from on-road transportation	15m
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6	Consolidate the above information into Table 4 and identify what activity data and emission factors you will need to estimate GHG emissions for Transportation, including different subsectors (GPC) and journey types (CRF), and where you will source this from	HW

Workbook: Task #2

GTALCC GHG Accounting - Participant handbook

Exercises	
Module B	Calculating GHG emissions
	Reviewing an inventory
Module C	Stationary energy
Module D	Transportation
Module E	Waste
Module F	IPPU and AFOLU

Tables	
Table 1	GHG emission sources
Table 2	Fuel types
Table 3	GPC
Table 4	Action plan

Reference
GPC
GWP
Notation keys
Checklist

Table 2: Fuel types

Sub-sector		Petrol / Gasoline	Diesel	CNG	Bio-diesel	Ethanol	Jet fuel	Electricity
II.1	On-road							
II.2	Railways							
II.3	Waterborne navigation							
II.4	Aviation							
II.5	Off-road							

Checklist: Fuel types

Scope 1		**Scope 2**
Aviation gasoline	Jet gasoline	Electricity
Biodiesels	Jet kerosene	
Biogasoline	Kerosene	
Compressed Natural Gas (CNG)	Liquefied Natural Gas (LNG)	
Diesel oil	Liquefied Petroleum Gas (LPG)	
E85	Methanol	
Electricity	Motor gasoline (petrol)	
Ethanol	Other biogas	
Hydrogen	Other Liquid BioFuels	
Gas oil	Residual fuel oil	

Table 1 & Table 2

Sub-sector		Sources of GHG emissions
II.1	On-road	
II.2	Railways	
II.3	Waterborne navigation	
II.4	Aviation	
II.5	Off-road	

Sub-sector		Petrol / Gasoline	Diesel	CNG	Bio-diesel	Ethanol	Jet fuel	Electricity
II.1	On-road							
II.2	Railways							
II.3	Waterborne navigation							
II.4	Aviation							
II.5	Off-road							

Practical

	Task	
1	Identify all sources of GHG emissions from energy use in transportation : • What activities (modes) are taking place? Consider both passenger and freight travel • Where are the emissions occurring? In boundary vs out of boundary. List them in Table 1	20m
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4	Use the induced activity methodology to estimate scope 2 emissions from railways	15m
5	Record your data in Table 3, clearly documenting methodologies and data sources used. For now, assume no scope 1 emissions from waterborne navigation and aviation. Where no GHG emissions occur or are deemed insignificant, use “NO”. For scope 3 sources, use “NE”.	HW
6	Consolidate the above information into Table 4 and identify what activity data and emission factors you will need to estimate GHG emissions for Transportation, including different subsectors (GPC) and journey types (CRF), and where you will source this from	HW

Calculations: On-road transportation

If your city has (access to) a good transportation model, use that to estimate emissions from for on-road transportation

Otherwise, the Fuel sales methodology is recommended

Assumption:

- All fuel sold in the city is used in the city (= scope 1 emissions)

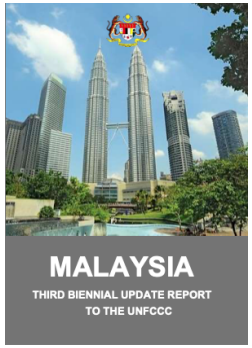
If local fuel sales data is not available, use a proxy city or **scale regional or national data**

Scaling factor

What makes a good scaling factor for scaling down national fuel sales data?

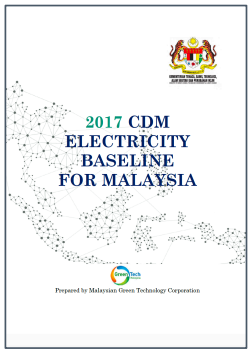
- Population
- GDP
- New vehicle sales
- # of garages
- Vehicle registrations

Materials: Task 3



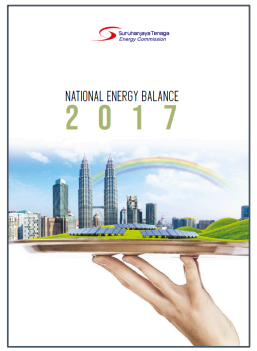
BUR3
Table 1.15 &
Table A2

IPCC Emission Factor Database

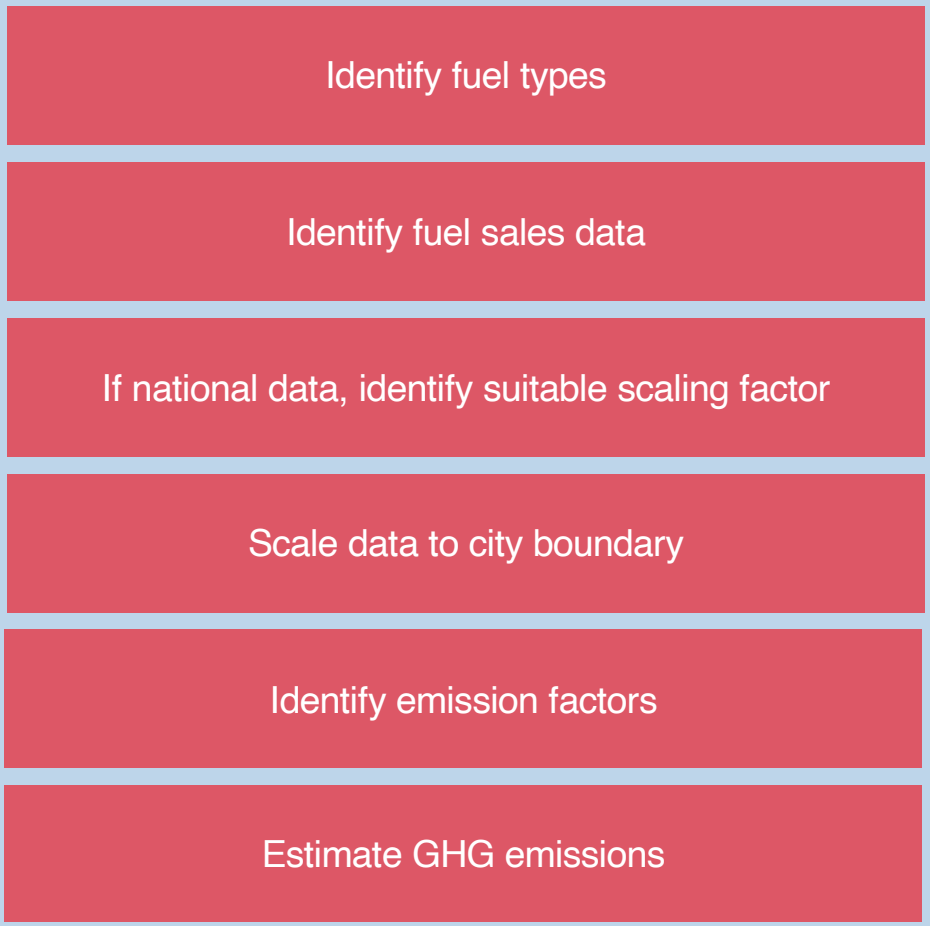


CDM 2017
Table 11

NEB 2017
Table 29



Calculations: On-road transportation



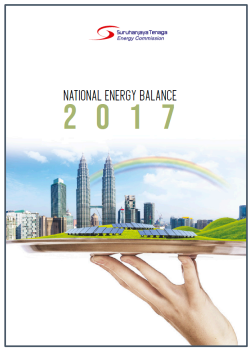
National Energy Balance 2017:

- Diesel
- Gasoline
- LPG
- Biodiesel

- Vehicle registrations (Malaysia Automotive Association)
- Population (BUR3)
- GDP (BUR3)
- Vehicle registrations per 100 population

Third Biennial Update Report

National Energy Balance 2017



Assumption: all fuel used for on-road transportation

(will need to correct for railways and other modes)

TABLE 29: ENERGY BALANCE TABLE IN 2017 (KILO TONNES OF OIL EQUIVALENT)

COMMERCIAL ENERGY BALANCE FOR MALAYSIA 2017 (KILO TONNES OF OIL EQUIVALENT)

ENERGY SOURCE	NATURAL GAS	LNG	CRUDE OIL (1/)	OTHERS (2/)	TOTAL PETROLEUM PRODUCTS	PETROLEUM PRODUCTS			
						PETROL	DIESEL	FUEL OIL	LPG
PRIMARY SUPPLY									
1. Primary Production	71,140	0	32,807	0	0	0	0	0	0
2. Gas Flaring, Reinjection & Use	-6,058	0	0	0	0	0	0	0	0
3. Imports	5,183	1,815	10,135	76	13,202	5,149	5,167	226	441
4. Exports	-1,452	-29,428	-14,958	-13	-11,063	-282	-5,133	-617	-208
5. Bunkers	0	0	0	0	-390	0	-93	-297	0
6. Stock Change	0	0	-297	0	143	49	65	-11	21
7. Statistical Discrepancy	0	0	-216	0	0	0	0	0	0
8. Primary Supply	**68,814**	**-27,613**	**27,471**	**63**	**1,941**	**4,917**	**6**	**-699**	**253**
TRANSFORMATION									
9. Gas Plants									
9.1 LNG	-36,964	29,428	0	0	40	0	0	0	40
9.2 MDS	-1,140	0	0	0	509	0	138	0	0
9.3 GPP-LPG (3&4/)	-2,008	0	0	0	1,961	0	0	0	1,961
9.4 RGT	1,815	-1,815	0	0	0	0	0	0	0
Subtotal	**-38,296**	**27,613**	**0**	**0**	**2,510**	**0**	**138**	**0**	**2,001**
10. Refineries	0	0	-27,252	-63	27,226	8,253	9,877	1,725	832
11. Power Stations & Self-Generation									
11.1 Hydro Stations	0	0	0	0	0	0	0	0	0
11.2 Thermal Stations	-11,872	0	0	0	-246	0	-147	-99	0
11.3 Self-Generation (5/)	-1,038	0	0	0	-226	0	-226	0	0
Subtotal	**-12,910**	**0**	**0**	**0**	**-472**	**0**	**-372**	**-99**	**0**
12. Losses & Own Use	-770	0	-219	0	-821	0	0	-29	0
13. Statistical Discrepancy	0	0	0	-0	177	267	-261	-319	429
14. Secondary Supply	**-51,976**	**27,613**	**-27,471**	**-63**	**28,921**	**8,520**	**9,382**	**1,278**	**3,261**
FINAL USE									
15. Residential	1	0	0	0	1,126	0	0	0	1,126
16 Commercial	25	0	0	0	270	0	22	5	244
17. Industrial	6,827	0	0	0	2,687	182	1,750	569	184
18 Transport	148	0	0	0	23,473	13,190	7,062	1	0
19. Agriculture	0	0	0	0	36	0	31	5	0
20. Fishing	0	0	0	0	588	66	523	0	0
21. Non-Energy Use	9,837	0	0	0	2,680	0	0	0	1,961
22. Total Final Use	**16,838**	**0**	**0**	**0**	**30,862**	**13,437**	**9,388**	**579**	**3,514**
ELECTRICITY OUTPUT									
Main Activity Producer									
Gross Electricity Generation - GWh	58,201	0	0	0	890	0	688	202	0
Autoproducer									
Gross Electricity Generation - GWh	3,930	0	0	0	805	0	805	0	0

KEROSENE	ATF & AV GAS	NON ENERGY	REFINERY GAS	COAL & COKE	HYDRO POWER	SOLAR	BIOMASS	BIOGAS	BIODIESEL	ELECTRICITY	TOTAL
0	0	0	0	1,884	6,240	93	194	41	467	0	112,867
0	0	0	0	0	0	0	0	0	0	0	-6,058
0	1,205	1,064	0	19,181	0	0	0	0	0	1	40,542
-60	-1,330	-3,433	0	-382	0	0	0	0	-239	-97	-57,632
0	0	-0	0	0	0	0	0	0	0	0	-390
4	3	12	0	58	0	0	0	0	32	0	-64
0	0	0	0	30	0	0	0	0	119	0	-67
-56	**-122**	**-2,368**	**0**	**20,771**	**6,240**	**93**	**194**	**41**	**379**	**-96**	**96,298**
0	0	0	0	0	0	0	0	0	0	0	-7,496
51	0	320	0	0	0	0	0	0	0	0	-631
0	0	0	0	0	0	0	0	0	0	0	-46
0	0	0	0	0	0	0	0	0	0	0	0
51	**0**	**320**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-8,173**
10	3,255	3,100	174	0	0	0	0	0	0	0	-80
0	0	0	0	0	-6,240	0	0	0	0	2,309	-3,931
0	0	0	0	-18,967	0	-93	-52	-40	0	11,066	-20,203
0	0	0	0	0	0	-0	-142	-1	0	445	-962
0	**0**	**0**	**0**	**-18,967**	**-6,240**	**-93**	**-194**	**-41**	**0**	**13,821**	**-25,096**
0	0	-317	-174	0	0	0	0	0	0	-1,057	-2,567
-0	87	-26	0	0	0	0	0	0	0	-61	116
61	**3,342**	**3,076**	**0**	**-18,967**	**-6,240**	**-93**	**-194**	**-41**	**0**	**12,703**	**-36,808**
3	0	0	0	0	0	0	0	0	0	2,610	3,739
0	0	0	0	0	0	0	0	0	0	3,762	4,057
3	0	0	0	1,804	0	0	0	0	0	6,145	17,463
0	3,220	0	0	0	0	0	0	0	379	39	24,039
0	0	0	0	0	0	0	0	0	0	50	86
0	0	0	0	0	0	0	0	0	0	0	588
0	0	719	0	0	0	0	0	0	0	0	12,017
5	**3,220**	**719**	**0**	**1,804**	**0**	**0**	**0**	**0**	**379**	**12,607**	**62,489**
0	0	0	0	68,866	26,841	330	185	142	0	0	166,406
0	0	0	0	0	5	0	426	12	0	0	5,178

1/ Crude production includes Condensates comprising Pentane and Heavier Hydrocarbons.
2/ Others Refer to Non-Crude Energy Forms (contrast of Imported Light Diesel, Slop Reprocess, Crude Residuum & Middle East Residue) Which are Used as Refinery Intake.
3/ GPP-LPG Extracts Liquid Products i.e Condensates, Ethane, Butane, Propane from Natural Gas, Ethane is Not Included under LPG production.
4/ Butane and Propane as MTBE Feedstocks are Presented as Non-Energy use under LPG column. Ethane is Presented under Natural Gas Column.
5/ Estimated figures based from the Energy Commission, Statistics of Electricity Supply Industry in Malaysia 2017.
Note : Total may not necessarily add up due to rounding

Source: NEB 2017

Biennial Update Report #3: Table 1.15

Table 1.15: Key Statistics for 2005 and 2016

Year	2005	2016
Latitude	0º 51' N - 7º 33' N	
Longitude	98º 01' E – 1 9º 30' E	
Area	330,345 km^2	
Coastline	8,840 km	
Mean daily temperature	26 – 28 ºC	
Average annual rainfall	2,000 – 4,000 mm	
Average daily direct sunlight	6 hours	
Forest Cover as % of total land area	53.9% (estimate)	55.5% (estimate)
Population	26.0 million	31.6 million
Population density	79 per km^2	96 per km^2
Female life expectancy	76.0 years	77.0 years
Male life expectancy	71.4 years	72.1 years
Age Profile	Below 15 years old – 30.9% 15 to 64 years old – 64.6% Above 65 years old – 4.5%	Below 15 years old – 24.5% 15 to 64 years old – 69.5% Above 65 years old – 6.0%
Urbanisation Rate	66.5%	74.8%
GDP (at 2010 constant prices)	RM 659,639 million	RM 1,108,900 million
GNI/capita (at 2010 constant prices)	RM 24,739	RM 37,822
Primary Energy Supply	66,211 ktoe	93,396 ktoe
Final Energy Demand	38,284 ktoe	57,218 ktoe
Total Electricity Consumption	73,987 GWh	116,529 GWh
Length of roads (Federal and State)	88,528 km	236,802 km
Motor vehicle registration	14,816,407	27,613,259
Annual Ridership on urban rail network in Greater Kuala Lumpur/ Klang Valley (passenger journeys)	157,475,402	210,498,247
Public transport modal share in Greater Kuala Lumpur/ Klang Valley	-	20%
Annual ridership on Stages Buses (11 towns and cities) (passenger journeys)	-	46,915
Solid Waste	-	33,130 tonnes/day (2012)

Population

GDP
(in million RM)

Transportation

Source: Malaysia Third Biennial Update Report to the UNFCCC

Malaysia Automotive Association (MAA)

Vehicle registration data up to June 30, 2017

State	Private Vehicles		Public Service Vehicles (PSV)	Goods Vehicles	Others	Total
	Motorcycles	Cars				
Perlis	84,500	26,510	385	2,007	1,365	114,767
Kedah	954,751	341,197	7,273	40,710	20,104	1,364,035
Penang	1,408,528	1,130,601	9,586	80,254	26,710	2,655,679
Perak	1,359,771	772,591	9,534	75,638	42,708	2,260,242
Selangor	1,423,821	1,157,268	24,273	194,390	104,724	2,904,476
Federal Territories	1,863,260	3,987,468	78,752	268,340	122,509	6,320,329
Negeri Sembilan	557,482	343,007	4,635	50,160	7,845	963,129
Melaka	472,701	344,459	3,425	28,486	8,830	857,901
Johor	1,873,005	1,498,587	20,365	153,471	66,183	3,611,611
Pahang	600,470	392,200	4,310	45,640	14,663	1,057,283
Terengganu	393,228	211,124	2,159	22,172	6,015	634,698
Kelantan	549,363	309,663	3,928	29,689	7,264	899,907
Sabah	402,237	697,541	9,574	116,292	65,807	1,291,451
Sarawak	798,227	813,569	5,834	95,373	71,782	1,784,785
Business Partner Portals	191,698	1,263,012	1,002	3,122	2,076	1,460,910
Total	**12,933,042**	**13,288,797**	**185,035**	**1,205,744**	**568,585**	**28,181,203**

Source: https://paultan.org/2017/10/03/vehicle-registrations-in-malaysia-hit-28-2-million-units/untitled-numbers/

Biennial Update Report #3: Table A2

Table A2: Summary of Emission Factors Used

		Emission factors								
		CO_2 (tC/TJ)	CH_4 (kg/TJ)	N_2O (kg/TJ)	HFCs	PFCs	SF_6	NF_3	NO_X	CO
ENERGY										
1A Fuel Combustion Activities										
1A1 Energy Industries										
1A1a	Electricity and Heat Production									
1A1ai	Electricity Generation									
	Diesel oil	20.2	3	0.6						
	Residual Fuel Oil	21.1	3	0.6						
	Sub-bituminous coal	26.2	1	1.5						
	Natural Gas	15.3	1	0.1						
1A1 b	Petroleum Refining									
	Crudel oil	20.0	3	0.6						
1A1 c	Manufacture of Solid Fuels and Other Energy Industries									
	Natural gas	15.3	1	0.1						
1A2 Manufacturing Industries and Construction										
	Gasoline	18.9	3	0.6						
	Other kerosene	19.6	3	0.6						
	Diesel oil	20.2	3	0.6						
	Residual Fuel Oil	21.1	3	0.6						
	LPG	17.2	1	0.1						
	Sub-bituminous coal	26.2	10	1.5						
	Natural gas	15.3	1	0.1						
1A3 Transport										
1A3 a	Civil Aviation									
1A3 aii	Domestic Aviation									
	Jet kerosene	19.5	0.5	2						
1A3 b	Road Transportation									
	Natural gas	15.3	92	3						
	Gasoline	18.9	33	3.2						
	Diesel Oil	20.2	3.9	3.9						
1A3 c	Railways									
	Diesel Oil	20.2	4.15	28.6						
1A3 d	Water-borne Navigation									
1A3 dii	Domestic Water-borne Navigation									
	Diesel Oil	20.2	7	2						
	Residual Fuel Oil	21.1	7	2						
1A4 Other Sectors										
1A4 a	Commercial/Institutional									
	Diesel Oil	20.2	10	0.6						
	Residual Fuel Oil	21.1	10	0.6						
	LPG	17.2	5	0.1						
	Natural Gas	15.3	5	0.1						
1A4 b	Residential									
	Other kerosene	19.6	10	0.6						
	LPG	17.2	5	0.1						
	Natural Gas	15.3	5	0.1						
1A4 c	Agriculture/Forestry/Fishing/Fish Farms									
1A4 ci	Stationary									
	Diesel Oil	20.2	10	0.6						
	Residual Fuel Oil	21.1	10	0.6						
1A4 cii	Off-road Vehicles and Other Machinery									
1A4 ciii	Fishing (mobile combustion)									
	Diesel Oil	20.2	5	0.6						
	Residual Fuel Oil	21.1	5	0.6						
1A5 Non-Specified										
1A5 a	Stationary									

Emission factors for **fossil fuels** (note CH_4 and N_2O not yet converted to CO_2e)

Source: Malaysia Third Biennial Update Report to the UNFCCC

Biodiesel

GHG emissions from biodiesel depend on the 'blend' used, or percentage of biogenic fuel:

- 100% biogenic = 0 CO_2 to account for the CO_2 absorbed by fast-growing bioenergy sources during their growth. Trace amounts of CH_4 and N_2O will occur.
- B10 = 10% palm oil, 90% diesel
- B20 = 20% palm oil, 80% diesel

To estimate fossil fuel GHG emissions, adjust the emission factor according to the blend used

The data reported in NEB 2017 for biodiesel consists of 100% biogenic fuel.

Emission factors for biodiesel difficult to find so use IPCC factors as default

- 70800 kg**CO_2(b)**/TJ
- 3 kg CH_4/TJ
- 0.6 N_2O/TJ

IPCC Emission Factor Dababase

Technical information	
Gas:	**METHANE**
IPCC 1996 Source/Sink Category:	**Energy (1) -> Fuel Combustion Activities (1A) -> Energy Industries (1A1)**
IPCC 2006 Source/Sink Category:	**Energy (1) -> Fuel Combustion Activities (1.A) -> Energy Industries (1.A.1)**
Fuel 1996:	**(Unspecified)**
Fuel 2006:	**Biodiesels**
Properties	
Technologies/Practices:	
Parameters/Conditions:	
Region/Regional Conditions:	
Abatement/Control Technologies:	
Others:	
Description:	CH4 Emission Factor for Stationary Combustion (kg/TJ on a net calorific basis)
Value:	**3 kg/TJ**
Value in common units:	
Equation:	Equation 2.1 in Volume 2 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
IPCC Worksheet:	1A, Sheet 4 of 4 (page A1.9) in Annex 1 of Volume 2, 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Source of data:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy, Table 2.2
Technical Reference:	Expert judgement by the authors of Chapter 2, Volume 2 of the 2006 IPCC Guidelines. For details, see Section 2.3.2.1, Chapter 2, Volume 2 of the 2006 IPCC Guidelines.
Reference language:	English
Abstract in English:	
Uncertainties expressed as 95% confidence limit:	**Upper:** 10 **Lower:** 1
Data quality:	Unknown
Distribution shape:	
Data quality reference:	
Other info on data quality:	

Source: https://www.ipcc-nggip.iges.or.jp/EFDB/ef_detail.php

Workbook: Tasks #3 & 4

GTALCC GHG Accounting - Participant handbook

Exercises	
Module B	Calculating GHG emissions
	Reviewing an inventory
Module C	Stationary energy
Module D	Transportation
Module E	Waste
Module F	IPPU and AFOLU

Tables	
Table 1	GHG emission sources
Table 2	Fuel types
Table 3	GPC
Table 4	Action plan

Reference
GPC
GWP
Notation keys
Checklist

On-road transportation: Activity data

Fuel type	ktoe	Convert to TJ	Scaling factor	Scaling ratio	City TJ
Diesel	NEB 2017	* 41.868		=city / national	=national TJ * scaling factor
Petrol	NEB 2017	* 41.868			=national TJ * scaling factor
~~LGP~~ Natural gas	NEB 2017	* 41.868			=national TJ * scaling factor
Biodiesel	NEB 2017	* 41.868			=national TJ * scaling factor

Units

ktoe = kilo tonne of oil equivalent
TJ = terajoules

Unit conversion

ktoe > TJ: multiply by 41.868

On-road transportation: Emission factor

Fuel type	CO_2 (tC/TJ)	Convert to tCO_2e/TJ	CH_4 (kg/TJ)	Convert to tCH_4/TJ	N_2O (kg/TJ)	Convert to tN_2O/TJ
Diesel	BUR3	* 44/12	BUR3	/ 1000	BUR3	/ 1000
Petrol	BUR3	* 44/12	BUR3	/ 1000	BUR3	/ 1000
~~LGP~~ Natural gas	BUR3	* 44/12	BUR3	/ 1000	BUR3	/ 1000
Biodiesel	Not occurring		IPCC	/ 1000	IPCC	/ 1000

Units

tC = tonnes of carbon

Unit conversion

tC > tCO_2: multiple by molecular weight ratio (44/12)
kg > t: divide by 1,000

On-road transportation: GHG emissions

Fuel type	CO_2	CH_4		N_2O		Total
	tCO_2e	tCH_4	tCO_2e	tN_2O	tCO_2e	tCO_2e
Diesel	=AD*EF	=AD*EF	* 25	=AD*EF	*298	
Petrol	=AD*EF	=AD*EF	* 25	=AD*EF	*298	
LGP	=AD*EF	=AD*EF	* 25	=AD*EF	*298	
Biodiesel	=AD*EF	=AD*EF	* 25	=AD*EF	*298	

4th Assessment Report GWP values

$CO_2 = 1$
$CH_4 = 25$
$N_2O = 298$

On-road transportation: Electric vehicles

Table 3.10: Transport: Energy-Efficient Vehicles (Hybrid and Electric Vehicles)

Mitigation Action	Objectives	Description	Key Implementing Agencies	Progress of implementation/ Steps taken or Envisaged to achieve action	Progress Indicators	Methodologies and Assumptions	Gas Cover-age	Results Achieved
Promo-ting the use of energy-efficient vehicles (EEVs)	To increase the number of on-the road EEVs in Malaysia	EEVs are defined as vehicles that meet a set of defined specification s in terms of carbon emission level (g CO_2eq/ km) and fuel consumption (L/100 km). EEVs include fuel-efficient internal combustion engine (ICE) vehicles, hybrid and electric vehicles, and alternative-fuelled vehicles.	Ministry of International Trade and Industry; Malaysia Automotive, Robotics and IoT Institute (MARii)	Six roadmaps have been established to support the implementation of National Automotive Policy 2014, viz. the Malaysia Automotive Technology Roadmap (MATR), Malaysia Automotive Supply Chain Development Roadmap (MASCR), Malaysia Automotive Human Capital Roadmap (MAHR), Development of Automotive Authorised Treatment Facilities Framework (ATF), Malaysia Automotive Bumiputera Development Roadmap (MABDR) and Malaysia Automotive Remanufacturing Roadmap (MARR). EEV incentives are given to OEMs that produce EEV certified models and based on merits of business proposal that evaluated through Cost Benefit Analysis (CBA) by MARii. Sale of Euro 5 diesel started in 2014. Rollout of EURO 4 Ron 97 petrol started in 2015.	Number of EEV vehicles registered under the Road Transport Depart-ment Malaysia.	Information on the number of registered EEV vehicles are obtained from the Road Transport Department. The difference in emissions of total EEVs on the road and the corresponding categories of conventional vehicles is then computed based on fuel consumption; Default average km driven per year per passenger vehicle in Malaysia as reported by Malaysian Institute of Road Safety Research (MIROS) is used; Default vehicle emission factors as reported by Department for Environment, Food and Rural Affairs (DEFRA), United Kingdom are used.	CO_2	Number of hybrid vehicles registered 2016: 53,310 Number of electric vehicles registered: 2016: 171 Emissions avoidance (Gg CO_2 eq): 2016: 90.65

Notation key?

Source: BUR3

Calculations: Railways

Methodology

- City-induced

Fuels

- **Electricity**
- Diesel

Assumptions

- Scope 1: For now, assume all diesel trains serve transboundary journeys (ie scope 3)
- Scope 2: For now, assume no inboundary freight transport
- Scope 3: Use notation key “NE”

Identify fuel types (electricity)

Determine fuel consumption (kWh)
or (passenger) kilometers travelled

If national/regional data,
identify suitable scaling factor

Scale data to city boundary

Identify emission factors

Estimate GHG emissions

Calculations: Railways

Multiple railway **networks** in Malaysia, and varies by region:

- KTM West Coast Line
- KTM East Coast line
- Light rapid transit (LRT)
- Mass rapid transit (MRT)
- Monorails
- Airport rail links
- Funicular (cable car)

Activity data:

- Electricity consumed (kWh)
- # of passengers
- # of journeys
- # of passenger kilometres (p-km)

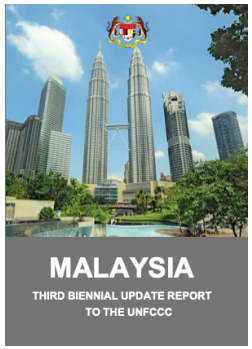
Scaling data:

- Population
- GDP
- Ratio of # of stops / stations (# of stops in your city / total # of stops)
- Ratio of length of railway tracks in your city (length in your city / total length)

Sourcing data:

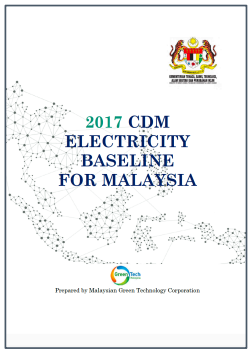
- Land Public Transport Agency (APAD)
- Ministry of Transport
- Transportation companies

Materials: Task 3



BUR3
Table 1.15

UK Government GHG conversion factors



CDM 2017
Table 11

Sustainable Cities & Society

Calculations: Railways

1. Source activity data. BUR3 (Table 1.15) provides annual ridership data for urban rail network in Greater Kuala Lumpur / Klang Valley

2. Adjust to city boundary using suitable scaling factor

3. Convert # of journeys to distance travelled (passenger kilometres) assuming average journey length of 9.8km

4. Convert distance travelled to electricity used in kWh assuming 0.126kWh / pkm

5. Estimate GHG emissions using emission factor for grid-electricity of 0.585 tCO_2 / MWh

Table 1.15: Key Statistics for 2005 and 2016

Year	2005	2016
Latitude	0° 51' N - 7° 33' N	
Longitude	98° 01' E – 1 9° 30' E	
Area	330,345 km^2	
Coastline	8,840 km	
Mean daily temperature	26 – 28 °C	
Average annual rainfall	2,000 – 4,000 mm	
Average daily direct sunlight	6 hours	
Forest Cover as % of total land area	53.9% (estimate)	55.5% (estimate)
Population	26.0 million	31.6 million
Population density	79 per km^2	96 per km^2
Female life expectancy	76.0 years	77.0 years
Male life expectancy	71.4 years	72.1 years
Age Profile	Below 15 years old – 30.9% 15 to 64 years old – 64.6% Above 65 years old – 4.5%	Below 15 years old – 24.5% 15 to 64 years old – 69.5% Above 65 years old – 6.0%
Urbanisation Rate	66.5%	74.8%
GDP (at 2010 constant prices)	RM 659,639 million	RM 1,108,900 million
GNI/capita (at 2010 constant prices)	RM 24,739	RM 37,822
Primary Energy Supply	66,211 ktoe	93,396 ktoe
Final Energy Demand	38,284 ktoe	57,218 ktoe
Total Electricity Consumption	73,987 GWh	116,529 GWh
Length of roads (Federal and State)	88,528 km	236,802 km
Motor vehicle registration	14,816,407	27,613,259
Annual Ridership on urban rail network in Greater Kuala Lumpur/ Klang Valley (passenger journeys)	157,475,402	210,498,247
Public transport modal share in Greater Kuala Lumpur/ Klang Valley	-	20%
Annual ridership on Stages Buses (11 towns and cities) (passenger journeys)	-	46,915
Solid Waste	-	33,130 tonnes/day (2012)

Source: BUR3

Calculations: Railways

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7.5m in Greater KL / Klang Valley

Source: BUR3

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Trip characteristics as the determinants of intention to shift to rail transport among private motor vehicle users in Kuala Lumpur, Malaysia

Soo Chen Kwan[a,b,*], Rosnah Sutan[b], Jamal Hisham Hashim[a]

[a] United Nations University – International Institute for Global Health, Kuala Lumpur, Malaysia
[b] Department of Community Health, National University of Malaysia, Kuala Lumpur, Malaysia

Table 3
Comparisons of trip characteristics by transport modes on the weekday and weekend.

	Trips (n)	Kilometres/trip			Minutes/trip			Speed (km/hour)		
		$\bar{x}$	IQR	p	$\bar{x}$	IQR	p	$\bar{x}$	IQR	p
Weekday (N = 1317)										
Private vehicles				0.228[a]			< 0.001[a]			< 0.001[a]
Car driver	859	10.0	13.8		20.0	30.0		24.0	21.0	
Car passenger	79	10.6	19.9		25.0	20.0		30.0	22.2	
Motorcyclist	247	9.8	16.4		18.0	20.0		31.8	27.0	
Public transport				0.025[b]			0.407 [b]			0.001[b]
Rail	108	10.5	10.6		20.0	15.5		33.0	21.6	
Bus	24	4.7	12.0		20.0	15.0		15.6	23.4	
Weekend (N = 953)										
Private vehicles				< 0.001[a]			< 0.001[a]			0.362 [a]
Car driver	645	12.3	13.7		20.0	15.0		30.0	24.6	
Car passenger	194	14.5	14.3		30.0	30.0		30.0	25.2	
Motorcyclist	41	5.0	10.7		10.0	12.5		30.0	27.0	
Public transport				0.995 [b]			< 0.001[b]			< 0.001[b]
Rail	55	7.9	11.5		15.0	17.5		34.8	18.6	
Bus	18	11.1	8.7		30.0	40.0		18.0	13.8	

[a] Kruskal Wallis H test [b]Mann-Whitney *U* test.

* 9.8 = ((10.5*5)+(7.9*2)) / 7

Source: http://collections.unu.edu/eserv/UNU:6749/jamal_2.pdf

Calculations: Railways

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UK Government GHG conversion factors for company reporting

Table 26: GHG emission factors, electricity consumption and passenger km for different tram and light rail services

	Type	Electricity use	gCO2e per passenger km				Million pkm
		kWh/pkm	CO_2	CH_4	N_2O	Total	
DLR (Docklands Light Rail)	Light Rail	0.113	31.16	0.08	0.17	31.41	**643.60**
Glasgow Underground	Light Rail	0.164	45.20	0.12	0.24	45.56	**40.44**
Midland Metro	Light Rail	0.135	37.22	0.09	0.20	37.52	**59.90**
Tyne and Wear Metro	Light Rail	0.389	107.00	0.27	0.58	107.85	**317.10**
London Overground	Light Rail	0.078	21.57	0.05	0.12	21.74	**1,480.22**
London Tramlink	Tram	0.108	29.82	0.08	0.16	30.06	**153.56**
Manchester Metrolink	Tram	0.078	21.58	0.05	0.12	21.75	**430.90**
Sheffield Supertram	Tram	0.350	96.29	0.25	0.52	97.06	**79.90**
Average* or Total		**0.126**	**34.80**	**0.09**	**0.19**	**35.07**	**3,206**

Notes: * Weighted by relative passenger km

Source: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/904215/2019-ghg-conversion-factors-methodology-v01-02.pdf

Calculations: Railways

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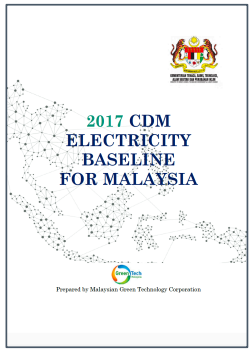

Table 11: Combined Margin emission factor for 2017

Regions	Combined Margin (CM) (tCO_2/MWh)
Peninsular Malaysia	0.585
Sabah	0.525
Sarawak	0.330

Source: https://www.greentechmalaysia.my/wp-content/uploads/2019/12/2017-CDM-Electricity-Baseline-Final-Report-Publication-Version.pdf

Practical

	Task	
1	Identify all sources of GHG emissions from energy use in transportation : • What activities (modes) are taking place? Consider both passenger and freight travel • Where are the emissions occurring? In boundary vs out of boundary. List them in Table 1	20m
2	Determine what types of fuel are being used. Complete Table 2	
3	Use the fuel sales methodology to estimate scope 1 emissions from on-road transportation	15m
4	Use the induced activity methodology to estimate scope 2 emissions from railways	15m
5	Record your data in Table 3, clearly documenting methodologies and data sources used. For now, assume no scope 1 emissions from waterborne navigation and aviation. Where no GHG emissions occur or are deemed insignificant, use “NO”. For scope 3 sources, use “NE”.	HW
6	Consolidate the above information into Table 4 and identify what activity data and emission factors you will need to estimate GHG emissions for Transportation, including different subsectors (GPC) and journey types (CRF), and where you will source this from	HW

Workbook: Task #5

GTALCC GHG Accounting - Participant handbook

Exercises	
Module B	Calculating GHG emissions
	Reviewing an inventory
Module C	Stationary energy
Module D	Transportation
Module E	Waste
Module F	IPPU and AFOLU

Tables	
Table 1	GHG emission sources
Table 2	Fuel types
Table 3	GPC
Table 4	Action plan

Reference
GPC
GWP
Notation keys
Checklist

Table 3: GPC table

Sub-sector		Scope 1	Scope 2	Scope 3
II.1	On-road			
II.2	Railways			
II.3	Waterborne navigation			
II.4	Aviation			
II.5	Off-road			

Record your data in Table 3, clearly documenting methodologies and data sources used. Where no GHG emissions occur or are deemed insignificant, use “NO”. For scope 3 sources, use “NE”.

Practical

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Workbook: Task #6

GTALCC GHG Accounting - Participant handbook

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Module E	Waste
Module F	IPPU and AFOLU

Tables	
Table 1	GHG emission sources
Table 2	Fuel types
Table 3	GPC
Table 4	Action plan

Reference
GPC
GWP
Notation keys
Checklist

Table 4: Action plan

GPC	Data	Where from?	Action	Lead
On-road				
Railways				
Waterborne navigation				
Aviation				
Off-road				

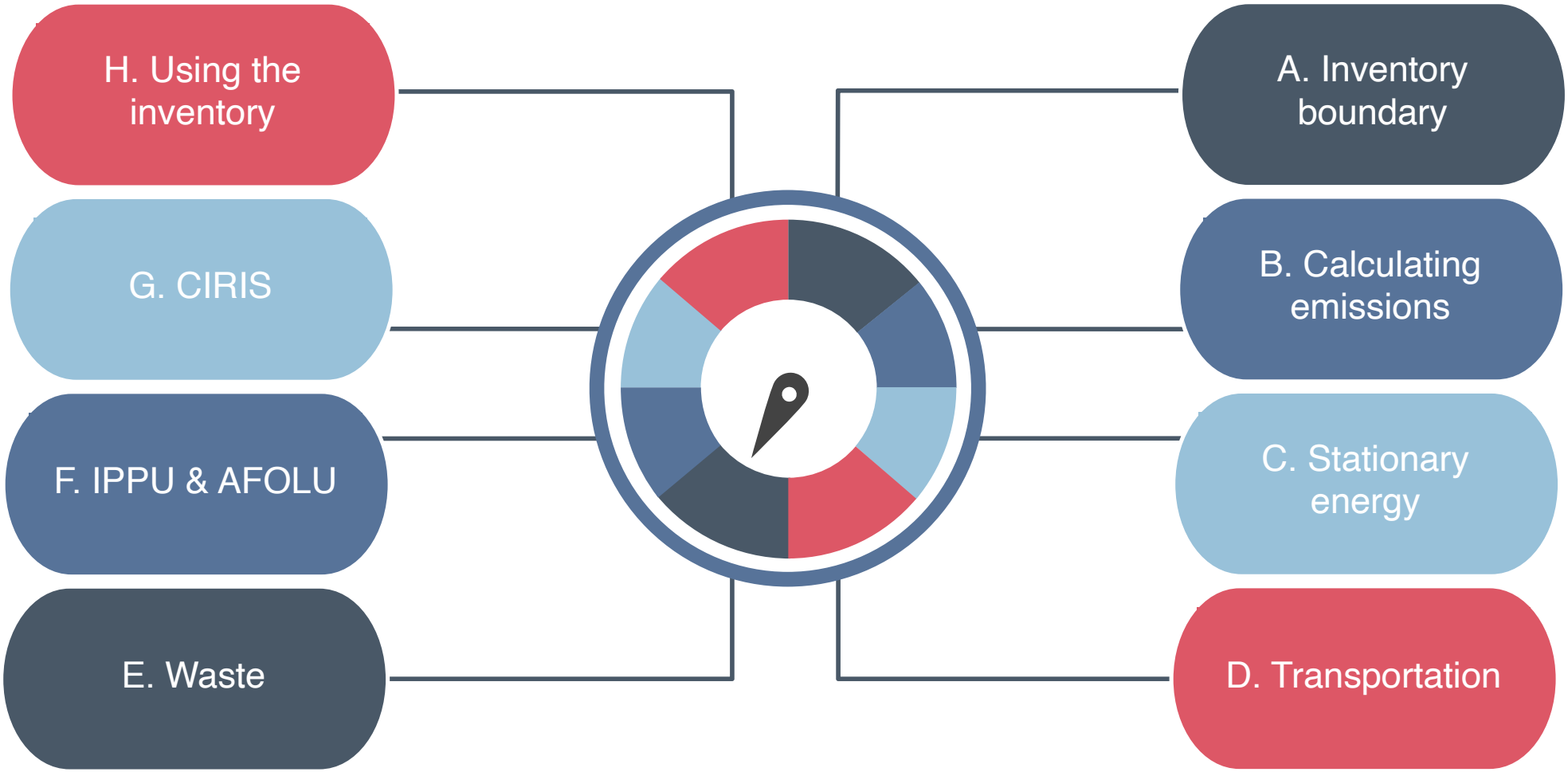
Consolidate all information into Table 4 and identify what activity data and emission factors you will need to estimate GHG emissions, and where you will source this from

03
SUMMARY

Module D: Transportation

Module D: Transportation

Overview	Transportation methodologies	Practical
01	02	03


H. Using the inventory
G. CIRIS
F. IPPU & AFOLU
E. Waste
A. Inventory boundary
B. Calculating emissions
C. Stationary energy
D. Transportation

The end

Next time: Waste