Green Technology Application for the
Development of Low Carbon Cities (GTALCC)

City-wide GHG accounting

15 March 2021

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15 March 2021

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Module B: Calculating GHG emissions

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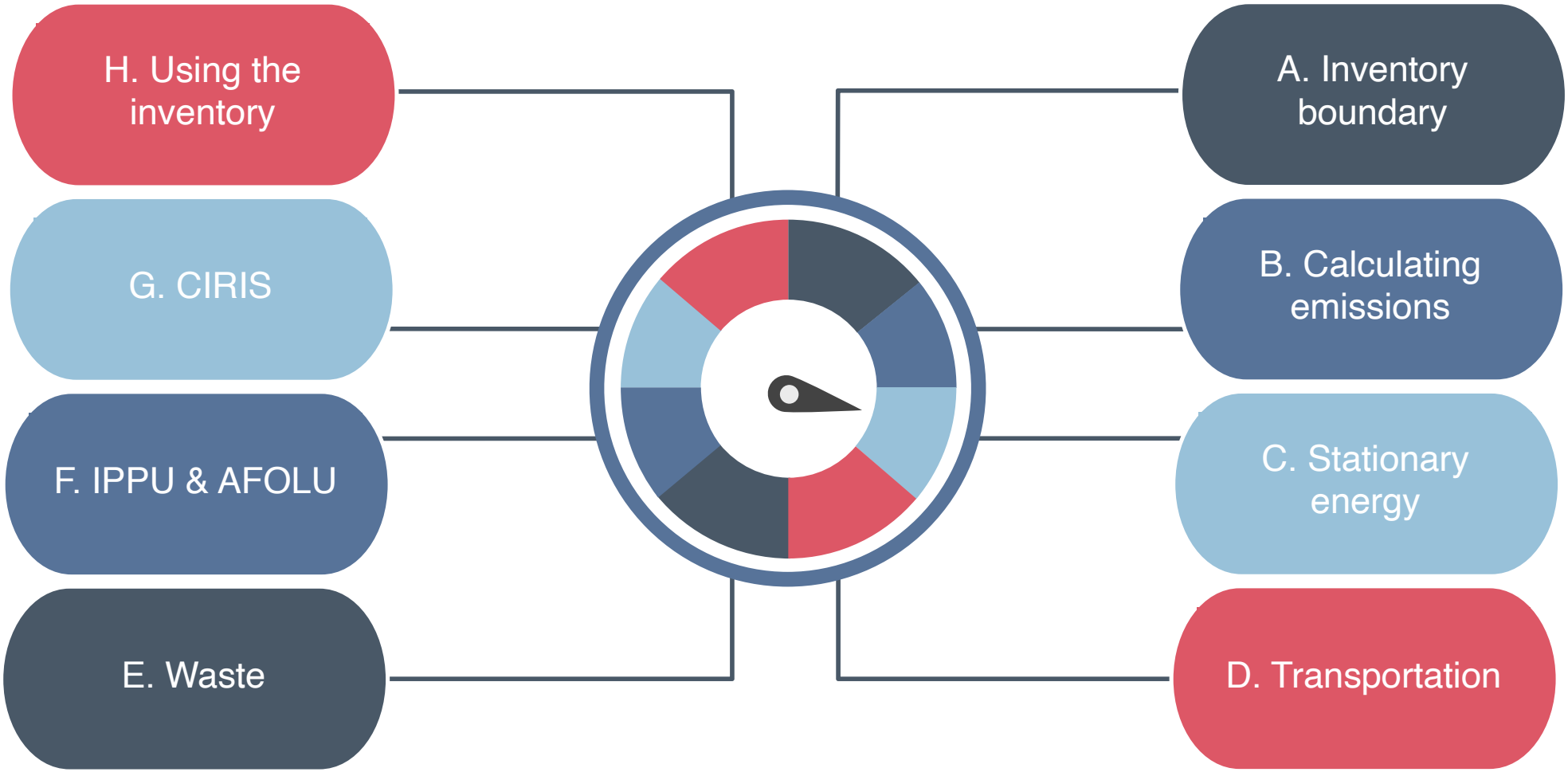
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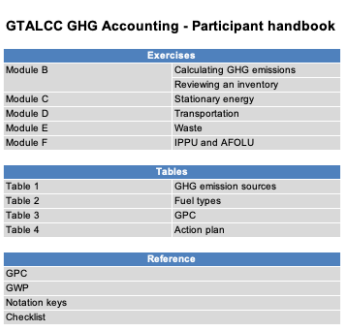

GTALCC GHG Accounting - Participant handbook

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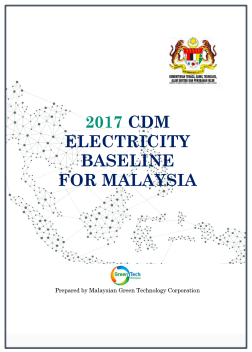

CDM 2017
Table 11

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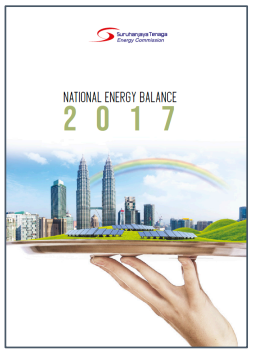


Module C

Stationary energy

01

Overview

Requirements

BASIC	**Cities shall report all GHG emissions from Stationary Energy sources and fugitive emissions in scope 1, and those from use of grid-supplied electricity, steam, heating, and cooling in scope 2**
BASIC+	**Cities shall report all BASIC sources and scope 3 GHG emissions associated with transmission and distribution (T&D) losses from grid-supplied electricity, steam, heating, and cooling**
Territorial	**Emissions from energy generation supplied to the grid shall be reported as part of total scope 1 emissions, but not included in BASIC/BASIC+ totals**

Categorising emissions

Scope 1	Scope 2	Scope 3
Emissions from fuel combustion and fugitive emissions in the city	**Emissions from the consumption of grid-supplied electricity, steam, heating and cooling in the city**	**Distribution losses from grid-supplied electricity, steam, heating and cooling in the city**
Scope 1 includes emissions from the combustion of fuels in buildings, industries, and from the conversion of primary energy sources in refineries and power plants located within the city boundary. Fossil resource exploration and refinement, including any offshore exploration that occurs within the city boundary, is also included in scope 1.	Electricity consumption is typically the largest source of scope 2 emissions. It occurs when buildings and facilities in the city consume electricity from local, regional or national electric grids. Grid-distributed steam, heat and cooling rely on smaller-scale distribution infrastructure, but may still cross city boundaries.	Scope 3 emissions include transmission and distribution losses from the use of grid supplied electricity, steam, heating and cooling in a city. Other upstream emissions from electricity supply may be reported in Other Scope 3.

Sub-sectors

Sub-sector		Definition
I.1	Residential buildings	All emissions from energy use in households
I.2	Commercial and institutional buildings and facilities	All emissions from energy use in commercial buildings and facilities
I.2	Commercial and institutional buildings and facilities	All emissions from energy use in public buildings such as schools, hospitals, government offices,highway street lighting, and other public facilities
I.3	Manufacturing industries and construction	All emissions from energy use in industrial facilities and construction activities, except those included in energy industries sub-sector. This also includes combustion for the generation of electricity and heat for own use in these industries.
I.4	Energy industries	All emissions from energy production and energy use in energy industries
I.4.4	Energy generation supplied to the grid	All emissions from the generation of energy for grid-distributed **electricity**, steam, heat and cooling

Sub-sectors

Sub-sector		Definition
I.5	Agriculture, forestry and fishing activities	All emissions from energy use in agriculture, forestry, and fishing activities
I.6	Non-specified sources	All remaining emissions from facilities producing or consuming energy not specified elsewhere
I.7	Fugitive emissions from coal	Includes all intentional and unintentional emissions from the extraction, processing, storage and transport of fuel in the city
I.8	Fugitive emissions from oil and gas systems	Fugitive emissions from all oil and natural gas activities occurring in the city. The primary sources of these emissions may include fugitive equipment leaks, evaporation losses, venting, flaring and accidental releases

Overview

Stationary energy sub-sectors	Scope 1	Scope 2	Scope 3
Residential buildings	I.1.1	I.1.2	I.1.3
Commercial and institutional buildings and facilities	I.2.1	I.2.2	I.1.2
Manufacturing industries and construction	I.3.1	I.3.2	I.3.3
Energy industries	I.4.1	I.4.2	I.4.3
Energy generation (electricity) supplied to the grid	I.4.4		
Agriculture, forestry, and fishing activities	I.5.1	I.5.2	I.5.3
Non-specified sources	I.6.1	I.6.2	I.6.3
Fugitive emissions from mining, processing, storage, and transportation of coal	I.7.1		
Fugitive emissions from oil and natural gas systems	I.8.1		

BASIC

BASIC+

Territorial

Not applicable

Other scope 3

Exercise: Stationary energy

Activity	Sub-sector and scope
Air conditioner at home	I.1.2
Wood barbeque at a local food market	I.2.1
Diesel back-up generator used at school	I.2.1
Electricity used in a car factory	I.3.2
Streetlighting	I.2.2
Flaring at oil refinery	I.8.1
Coal used to generate electricity	I.4.4
Lights on at City hall	I.2.2

Data needs

Sub-sector		Elec.	Gas	Kerosene	Diesel	Biomass	Oil	LPG
I.1	Residential buildings	Lighting, appliances, AC	Cooking, heating	Lighting, cooking	Generator	Cooking		Cooking
I.2	Commercial and institutional buildings and facilities	Lighting, appliances, AC	Cooking, heating		Generator			Cooking
I.3	Manufacturing industries and construction	✔	✔		✔		✔	✔
I.4	Energy industries							
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 gas systems		✔					

Module C

Stationary energy

02

Fuel combustion

Residential, commercial and institutional buildings and facilities

Residential	Commercial	Institutional	Facilities
Houses	Retail outlets	Schools	Street lighting
Flats	Shopping complexes	Hospitals	Parking
	Office buildings	Police stations	Public recreation areas
		Government offices	Waste depot

Note: **Common Reporting Framework** requires cities to report GHG emissions from commercial and institutional buildings and facilities **separately**. Use notation key IE if not possible

Multi-function uses for buildings & facilities

Multi-function uses for buildings and facilities
➢ Subdivide mixed use buildings based on square meters of a building (and “subdivide” the activity data and resulting emissions)
➢ Categorize buildings according to their designated usages
➢ Categorize the entire building under one of the sub-categories and provide justification

Manufacturing industries and construction

This sub-sector includes energy use in manufacturing industries and construction activities

Fuel combustion occurs in stationary equipment, including: boilers, furnaces, burners, turbines, heaters, incinerators, engines etc

Where data are available, GHG emissions from relevant sub-categories should be reported using the 13 sub-categories identified in the IPCC Guidelines

Sub-categories[28]	ISIC Classification	Description
Iron and steel	ISIC Group 271 and Class 2731	Manufacture of primary iron and steel products, including the operation of blast furnaces, steel converters, rolling and finishing mills, and casting
Non-ferrous metals	ISIC Group 272 and Class 2732	Production, smelting, and refinement of precious metals and other non-ferrous metals from ore or scrap
Chemicals	ISIC Division 24	The manufacture of basic chemicals, fertilizer and nitrogen compounds, plastics, synthetic rubber, agro-chemical products, paints and coatings, pharmaceuticals, cleaning agents, synthetic fibers, and other chemical products
Pulp, paper and print	ISIC Divisions 21 and 22	Pulp, paper, paperboard, paper products; publishing and reproduction of recorded media
Food processing, beverages, and tobacco	ISIC Divisions 15 and 16	Production, processing, and preservation of food and food products, beverages, and tobacco products
Non-metallic minerals	ISIC Division 26	Manufacture and production of glass and glass products, ceramics, cements, plasters, and stone
Transport equipment	ISIC Divisions 34 and 35	Motor vehicles, trailers, accessories and components, sea vessels, railway vehicles, aircraft and spacecraft, and cycles
Machinery	ISIC Divisions 28, 29, 30, 31, 32	Fabricated metal products, machinery and equipment, electrical machinery and apparatuses, communications equipment, and associated goods
Mining (excluding fuels) and quarrying	ISIC Divisions 13 and 14	Mining of iron, non-ferrous ores, salt, and other minerals; quarrying of stone, sand, and clay
Wood and wood products	ISIC Division 20	Sawmilling and planning of wood; the production of wood products and cork, straw, and other wood-based materials
Construction	ISIC Division 45	Site preparation, construction installation, building completion, and construction equipment
Textile and leather	ISIC Division 17, 18, 19	Spinning, weaving, dyeing, of textiles and manufacture of apparel, tanning and manufacture of leather and footwear
Non-specific industries	Activities not included above	Any manufacturing industry/construction not included above, including water collection, treatment, supply; wastewater treatment and disposal; and waste collection, treatment, and disposal

Energy industries

Activity	Breakdown
Primary fuel production	• Coal mining • Oil and gas extraction
Fuel processing and conversion	• Crude oil to petroleum products in refineries • Coal to coke and coke oven gas in coke ovens
Energy production supplied to a grid	• Electricity generation (includes incineration of waste for energy) • Combined heat and power generation (CHP) • District heating / cooling • Auxiliary energy use (energe used on site before distributed to grid)

GHG emissions from energy used shall be reported as I.4.1, I.4.2 and I.4.3

GHG emissions from energy generated and supplied to the grid shall be reported as I.4.4

Agriculture, forestry, and fishing activities

This sub-sector covers GHG emissions from direct fuel combustion in agricultural activities, including plant and animal cultivation, afforestation and reforestation activities, and fishery activities (e.g., fishing and aquaculture).

These emissions are typically from the operation of farm vehicles and machinery, generators to power lights, pumps, heaters, coolers, and others.

Sources of emissions	Reporting guidance
Off-road vehicles and machinery (stationary and mobile) used for agriculture, forestry, and fishing activities	Stationary energy (I.6)
On-road transportation to and from the locations of agriculture, forestry, and fishing activities	Transportation
Burning of agricultural residues	AFOLU
Enteric fermentation and manure management	AFOLU

Module C

Stationary energy

03

Fugitive emissions

Fugitive emissions

A small portion of emissions from the energy sector frequently arises as fugitive emissions, which typically occur during **extraction, transformation, and transportation** of primary fossil fuels.

Mining, processing, storage, and transportation of coal

The geological processes of coal formation produce CH_4 and CO_2, collectively known as seam gas. It is trapped in the coal seam until the coal is exposed and broken during mining or post-mining operations, which can include handling, processing, and transportation of coal, low temperature oxidation of coal, and uncontrolled combustion of coal. At these points, the emitted gases are termed fugitive emissions.

Oil and natural gas systems

Fugitive emissions from oil and natural gas systems include GHG emissions from all operations to produce, collect, process or refine, and deliver natural gas and petroleum products to market. Specific sources include, but are not limited to, equipment leaks, evaporation and flashing losses, venting, flaring, incineration, and accidental releases

Module C

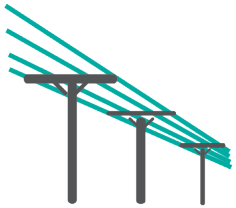
Stationary energy

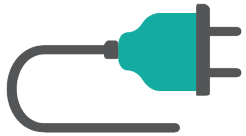
04

Grid-supplied energy consumption

Grid-supplied energy consumption

- Scope 2 represents all grid-supplied electricity, steam, heating and cooling consumed within the city boundary.
- Electricity is the most common form of grid-supplied energy, used in almost all homes, offices, other buildings, and outdoor lighting.
- Grid-supplied energy in the form of direct steam (heating) and/or chilled water (cooling) is typically provided by district energy systems, which may cover a smaller geographic area than electricity grids, which are typically regional.





- In all cases, using grid-supplied energy entails emissions produced at generation facilities off-site from the consumption facilities.
- Depending on the city and the structure of the grid, these energy generators can be located outside the geographic boundary at various locations tied to or exporting to the regional grid, or from generators located within the city boundary.

Location-based and market-based calculation methods

With regional grid networks, energy consumers can assess emissions from their consumption based on two methods: location-based or market-based method

Location-based method

A location-based method is based on average energy generation emission factors for defined locations, including local, sub-national or national boundaries. It yields a grid average emission factor representing the energy produced in a region, and allocates that to energy consumers in that region

Market-based method

The market-based method allocates emissions from energy generators to consumers based on “contractual instruments” such as renewable energy certificates or other contracts (e.g. green tariffs).

Cities shall use the location-based method for scope 2 calculations in the GPC, and may separately document emissions from the market-based method

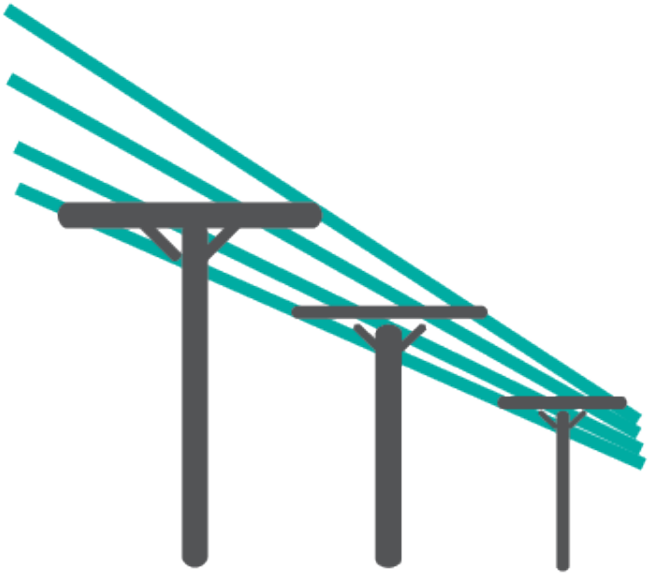
Calculating grid-supplied electricity emissions

Activity data	• **Real consumption data, disaggregated by building type / facility**:
	  • Where such data is unavailable, but total community energy consumption data for buildings are available, apportion by total built space for each building type.
	  • Where data are only available for a few of the total number of energy utilities, determine the population served by real data to scale-up for total city-wide energy consumption. Alternately use built space as the scaling factor.
	  • Where data are only available for one building type, determine an energy end-use intensity figure by using built space of that building type, and use as a scaling factor with total built space for the other building types.
	• **Representative sample sets of real consumption data** from surveys scaled up for total city-wide fuel consumption and based on total built space for each building type
	• **Modeled energy consumption data** by building type / facility, adjusted for inventory-year consumption data by weather.
	• **Regional or national consumption data** scaled down using population, adjusted for inventory-year consumption data by weather.

Emissions factor	• Cities should use regional or sub-national grid average emissions factors. If these are not available, national electricity production emission factors may be used

Transmission and distribution losses

- During the transmission and distribution of electricity, steam, heating and cooling on a grid, some of the energy produced at the power station is lost during delivery to end consumers
- Emissions associated with these transmission and distribution losses are reported in scope 3 as part of out-of-boundary emissions associated with city activities (I.X.3)
- Calculating these emissions requires a **grid loss factor**, which is usually provided by local utility or government publications
- T&D = Activity data * grid loss factor * grid emission factor



Relationship between energy generation and energy consumption

- Cities may have energy generation facilities located inside the geographic boundary for the inventory
- In most instances a city cannot prove that its energy consumption is supplied by the resources located within the boundary
- While it is generally the case that a city's aggregate energy demand will be met with a set of local generation resources, **cities cannot assume that their aggregate electricity consumption from regional electricity grids is met in full or in part by energy produced within the city boundary.**

- This is not possible to guarantee due to fluctuating regional demand at any given moment, grid constraints, exports and other contractual arrangements
- Therefore, **cities shall report scope 2 emissions from all grid-supplied energy consumed in the city, and separately report scope 1 emissions from all inboundary energy generation supplied to a regional / national grid (I.4.4)**
- BASIC/BASIC+ reporting avoids double counting by excluding scope 1 emissions from energy generation supplied to the grid (I.4.4)

Energy generation (I.4.4)

GPC

- Used for Territorial total NOT City-induced (BASIC/BASIC+) total
- Only includes GHG emissions from energy produced within the geographic boundary of the city

CRF

- For information only and not added to total GHG emissions
- **Measures GHG emissions from energy produced within the geographic boundary of the city AND facilities outside the city boundary but that can be *controlled or influenced* by the city**
- *Should* disaggregate by electricity only, CHP and hot/cold generation

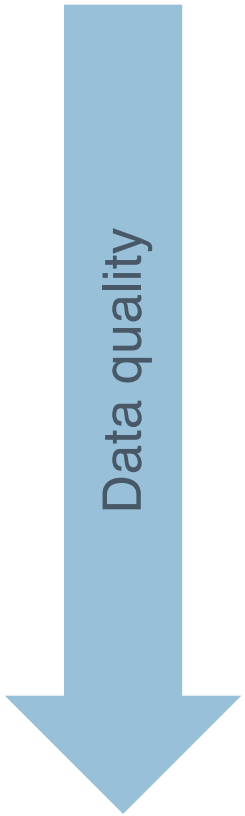
Module C

Stationary energy

05

Case studies

Energy consumption (I.1.1and I.1.2)



Cape Town

Bottom-up modelling based on estimated GJ / household and # of households using paraffin

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Stockholm

Total energy use data from supplier disaggregated into sub-sectors based on floor area of buildings

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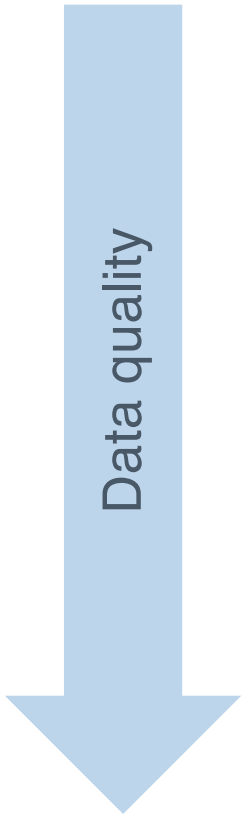
London

Energy use from supplier by user

Energy generation (I.4.4)



London

Expert identified power stations within city and estimated capacity, fuel type and load factor

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Mexico City

Activity data from company report submitted to Secretary of Environment. IPCC emission factors

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Copenhagen

Owns energy utility and obtains energy generation and fuel type data direct from supplier

Fugitive emissions (I.8.1)

Washington DC

Default emission factor

*Total gas consumption * IPCC emission factor*

San Francisco

Proxy city

*Total gas consumption * NYC emission factor * 0.8*

New York City

Gas operator

Series of measurements, extrapolated across city

Data hacks

Sub-sector	Definition
Real consumption data for each fuel type, disaggregated by sub-sector.	• This information is typically monitored at the point of fuel use or fuel sale, and should ideally be obtained from utility or fuel providers. Depending on the type of fuel dispensary, fuel sales may be for Stationary Energy sources or for mobile Transportation sources. Cities should ensure sales information is disaggregated between these two sectors.
A representative sample set of real consumption data from surveys.	• While surveying for fuel consumption for each sub-sector, determine the built space (i.e., square meters of office space and other building characteristics) of the surveyed buildings for scaling factor
Modeled energy consumption data	• Determine energy intensity, by building and/or facility type, expressed as energy used per square meter (e.g., GJ/m2/year) or per unit of output.
Incomplete or aggregate real consumption data	• Where fuel consumption data by sub-sector are unavailable, but data are available for total emissions, apportion by total built space for each sub-sector or building type. • Where data are only available for a few of the total number of fuel suppliers, determine the population (or other indicators such as industrial output, floor space, etc.) served by real data to scale-up the partial data for total city-wide energy consumption. • Where data are only available for one building type, determine a stationary combustion energy intensity figure by using built space of that building type, and use as a scaling factor with built space for the other building types.
Regional or national fuel consumption data scaled down using population or other indicators	• The rest of Section 6.3 applies this emissions calculation method to each energy sub-sector, identifying further sub-categories and clarifying where emissions from multifunctional buildings or related sectoral operations should be reported.

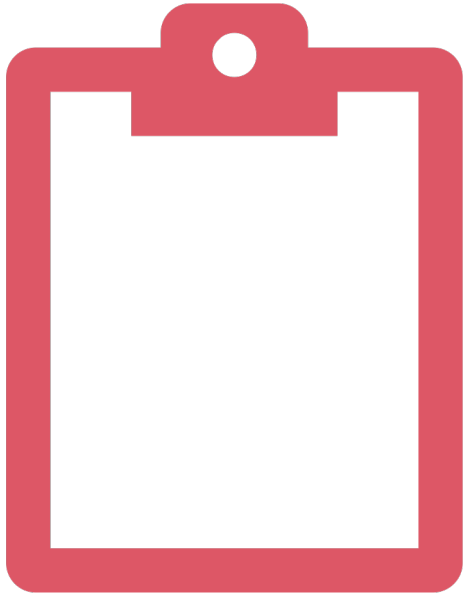
Module C

Stationary energy

06

Practical

Practical



Practical

	Task	
1	Identify all sources of GHG emissions from energy use in buildings across your city: • What activities are taking place? • Where are the emissions occurring? List them in Table 1	10m
2	Determine what types of fuel are being used. Complete Table 2	10m
3	Estimate scope 1 and 2 GHG emissions for Residential (I.1), Commercial & Institutional (I.2) and Manufacturing industries (I.3) sub-sectors using national fuel use data	30m
4	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”.	10m
5	Consolidate the above 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	15m

Practical: Task #1

	Task	
1	Identify all sources of GHG emissions from energy use in buildings across your city: • What activities are taking place? • Where are the emissions occurring? List them in Table 1	10m
2	Determine what types of fuel are being used. Complete Table 2	10m
3	Estimate scope 1 and 2 GHG emissions for Residential (I.1), Commercial & Institutional (I.2) and Manufacturing industries (I.3) sub-sectors using national fuel use data	30m
4	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”.	10m
5	Consolidate the above 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	15m

Workbook: Task #1

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Tables	
Table 1	GHG emission sources
Table 2	Fuel types
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Workbook: Task #1

Table 1: GHG emission sources

Stationary: GHG emission sources

Sub-sector	Sources of GHG emissions
I.1 Residential	
I.2 Commercial	
I.2 Institutional	
I.3 Manufacturing	
I.4 Energy industries	
I.5 Agriculture	
I.6 Non-specific sources	
I.7 Fugitive emissions from coal	
I.8 Fugtive emissions from oil and gas	

Table 1: GHG emission sources

Sub-sector		Icon	Sources of GHG emissions
I.1	Residential buildings		Electricity for A/C
I.2	Commercial and institutional buildings and facilities		
I.3	Manufacturing industries and construction		
I.4	Energy industries		
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 gas systems		

Task 1:

Identify all sources of GHG emissions from energy use in buildings across your city:

- What activities are taking place?
- Where are the emissions occurring?

Practical: Task #2

	Task	
1	Identify all sources of GHG emissions from energy use in buildings across your city: • What activities are taking place? • Where are the emissions occurring? List them in Table 1	10m
2	Determine what types of fuel are being used. Complete Table 2	10m
3	Estimate scope 1 and 2 GHG emissions for Residential (I.1), Commercial & Institutional (I.2) and Manufacturing industries (I.3) sub-sectors using national fuel use data	30m
4	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”.	10m
5	Consolidate the above 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	15m

Workbook: Task #2

GTALCC GHG Accounting - Participant handbook

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Workbook: Task #2

Table 2: Fuel types

Stationary: Fuel types

Sub-sector	Electricity	Gas	LPG	Kerosene	Diesel	Petrol	Fuel oil	Other	Other
I.1 Residential									
I.2 Commercial									
I.2 Institutional									
I.3 Manufacturing									
I.4 Energy industries									
I.5 Agriculture									
I.6 Non-specific sources									
I.7 Fugitive emissions from coal									
I.8 Fugtive emissions from oil and gas									

Checklist: GPC sub-categories

Sub-sector		Sub-categories
I.1	Residential buildings	
I.2	Commercial and institutional buildings and facilities	Commercial, Institutional, Streetlighting
I.3	Manufacturing industries and construction	Manufacturing industries and construction (1.A.2), Iron and steel (1.A.2), Non-ferrous metals (1.A.2.b), Chemicals (1.A.2.c), Pulp, paper and print (1.A.2.d), Food processing, beverages and tobacco (1.A.2.e), Non-metallic minerals (1.A.2.f), Transport equipment (1.A.2.g), Machinery (1.A.2.h), Mining (excl. fuels) and quarrying (1.A.2.i), Wood and wood products (1.A.2.j), Construction (1.A.2.k), Textile and leather (1.A.2.l), Non-specified industry (1.A.2.m)
I.4	Energy industries	Electricity generation (1.A.1.a.i), Combined heat and power generation (1.A.1.a.ii), Heat plants (1.A.1.a.iii), Petroleum refining (1.A.1.b), Manufacture of solid fuels (1.A.1.c.i), Other energy industries (1.A.1.c.ii)
I.5	Agriculture, forestry, and fishing activities	Stationary (1.A.4.c.i), Off-road vehicles and other machinery (1.A.2.ii), Fishing (mobile combustion) (1.A.4.c.iii)
I.6	Non-specified sources	Stationary (1.A.5.a), Mobile (1.A.5.b)
I.7	Fugitive emissions from coal	
I.8	Fugitive emissions from oil and gas systems	

Table 2: Fuel types

Sub-sector		Elec.	Gas	LPG	Kerosene	Diesel	Petrol	Fuel oil
I.1	Residential buildings							
I.2	Commercial and institutional buildings and facilities							
I.3	Manufacturing industries and construction							
I.4	Energy industries							
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 gas systems							

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

Checklist: Fuel types

Scope 1				Scope 2
Aviation gasoline	Compressed Natural Gas (CNG)	Landfill gas	Other Liquid BioFuels	Electricity
Biodiesels	Crude oil	Liquefied Natural Gas (LNG)	Petroleum coke	Electricity (CHP)
Biogasoline	Diesel oil	Liquefied Petroleum Gas (LPG)	Propane	Heating
Bitumen	E85	Lubricants	Residual fuel oil	Heating (CHP)
Butane	Ethanol	Methanol	Sewage sludge	Steam
Charcoal	Hydrogen	Motor gasoline (petrol)	Sludge gas	Steam (CHP)
Coal (Bituminous or Black coal)	Gas oil	Municipal wastes (all)	Town gas or city gas	Cooling
Coke	Jet gasoline	Naphtha	Wood or wood waste	Cooling (CHP)
Coking coal	Jet kerosene	Natural gas		
Coal (manufactured solid fuels)	Kerosene (paraffin)	Other biogas		

Table 2: Fuel types

Sub-sector		Elec.	Gas	LPG	Kerosene	Diesel	Petrol	Fuel oil
I.1	Residential buildings				Cooking		x	
I.2	Commercial and institutional buildings and facilities							
I.3	Manufacturing industries and construction							
I.4	Energy industries							
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 gas systems							

Task 2:

Determine what types of fuel are being used.

Practical: Task #3

	Task	
1	Identify all sources of GHG emissions from energy use in buildings across your city: • What activities are taking place? • Where are the emissions occurring? List them in Table 1	10m
2	Determine what types of fuel are being used. Complete Table 2	10m
3	Estimate scope 1 and 2 GHG emissions for Residential (I.1), Commercial & Institutional (I.2) and Manufacturing industries (I.3) sub-sectors using national fuel use data	30m
4	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”.	10m
5	Consolidate the above 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	15m

Workbook: Task #3

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

Workbook: Task #3

Module C: Stationary Energy

1. Estimate scope 1 and 2 GHG emissions for Residential (I.1), Commercial & Institutional (I.2) and Manufacturing industry (I.3)

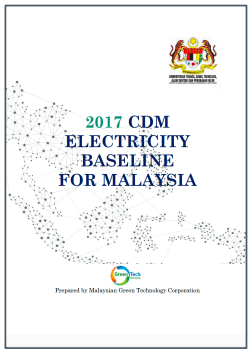
1a. Identify activity data from data provided in Table 29 of the National Energy Balance 2017

Fuel type	I.1 Residential		I.2 Commercial & Institutional		I.3 Manufacturing industry	
	ktoe	Convert to TJ	ktoe	Convert to TJ	ktoe	Convert to TJ
Natural gas						
LPG						
Kerosene						
Petrol						
Diesel						
Fuel oil						
Coal & Coke						
Electrcity						

Materials: Task 3

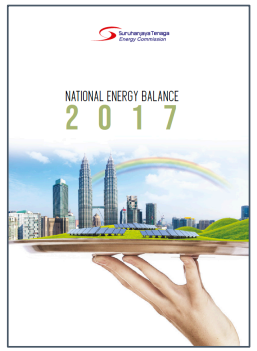
BUR3
Table 1.15 &
Table A2

Why NEB 2017?



CDM 2017
Table 11

NEB 2017
Table 29



Task 3: Stationary energy

Estimate scope 1 and 2 GHG emissions for:

- Residential (I.1)
- Commercial & Institutional (I.2)
- Manufacturing industries (I.3)

Preferred sources of data:

- Local energy use data / estimates
- Floor area breakdown * energy intensities

Otherwise >> **scale national energy use data**

Task 3: Stationary energy

Scaling factor

What makes a good scaling factor for scaling down national energy data for **Residential**, **Commercial and Institutional** and **Manufacturing industries** sub-sectors?

- Population
- # of buildings
- GDP
- # of companies registered

Note, assumptions:

- No Energy industries (I.4)
- No Agriculture, forestry, and fishing activities (I.5)
- No Non-specified sources (I.6)
- No Fugitive emissions from coal activities (I.7)
- Fugitive emissions from gas (I.8) are negligible (ie. insignificant)

Task 3: Stationary energy

- Identify fuel types
- Identify fuel consumption data
- If national data, identify suitable scaling factor
- Scale data to city boundary
- Identify emission factors
- Estimate GHG emissions

Task 3: Stationary energy

- Identify fuel types
- Identify fuel consumption data
- If national data, identify suitable scaling factor
- Scale data to city boundary
- Identify emission factors
- Estimate GHG emissions

National Energy Balance 2017 Table 29

- Natural gas / LGP / Kerosene
- Petrol / Diesel / Fuel oil
- Coal / Coke
- Electricity

Third Biennial Update Report Table 1.15

- Population for Residential
- GDP for Commercial & Industrial

Third Biennial Update Report Table A2
2017 CDM electricity baseline for Malaysia Table 11

National Energy Balance 2017: Table 29

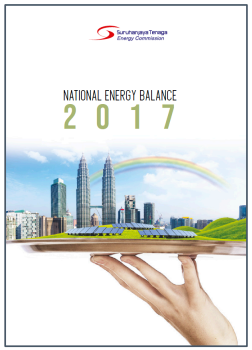


TABLE 29: ENERGY BALANCE TABLE IN 2017 (KILO TONNES OF OIL EQUIVALENT)

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	12,817
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

Activity data

Source: NEB 2017

Biennial Update Report #3: Table 1.15

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)

Population

GDP
(in million RM)

Source: Malaysia Third Biennial Update Report to the UNFCCC

Kuala Lumpur GPC inventory

CITY	INVENTORY YEAR	POPULATION	GDP (MILLION USD)	AREA (KM2)
Kuala Lumpur (Malaysia)	2017	1,793,000	52,097	243

	Scope 1	Scope 2	Scope 3
Kuala Lumpur	**15,548,891**	**8,969,058**	**576,105**
Stationary	**1,472,306**	**8,882,384**	**0**
Residential buildings	182,833	2,365,581	0
Commercial and institutional building and facilities	174,796	5,857,396	0
Manufacturing industries and construction	1,031,904	659,407	0
Energy industries	0	0	0
Agriculture, forestry and fishing activities	0	0	0
Non-specified sources	0	0	0
Fugitive emissions from mining, processing, storage and transportation of coal	0	0	0
Fugitive emissions from oil and natural gas systems	82,773	0	0
Transport	**13,875,481**	**86,674**	**0**
On-road transportation	13,875,481	0	0
Railways	0	86,674	0
Waterborne navigation	0	0	0
Aviation	0	0	0
Off-road transportation	0	0	0
Waste	**201,104**	**0**	**576,105**
Solid waste disposal	0	0	572,481
Biological treatment of waste	0	0	1,355
Incineration and open burning	0	0	2,269
Wastewater treatment and discharge	201,104	0	0

Potential scaling factors

(note 1 RM = 0.24 USD)

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

2017 CDM electricity baseline: Table 11

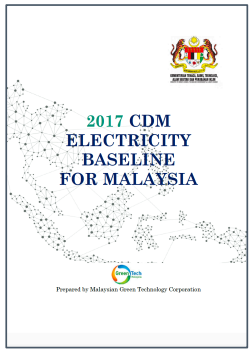


Table 11: Combined Margin emission factor for 2017

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

What about CH_4 and N_2O?

Emission factor for **electricity** (note CO_2 only)

Source: Greentech 2017 CDM electricity baseline for Malaysia

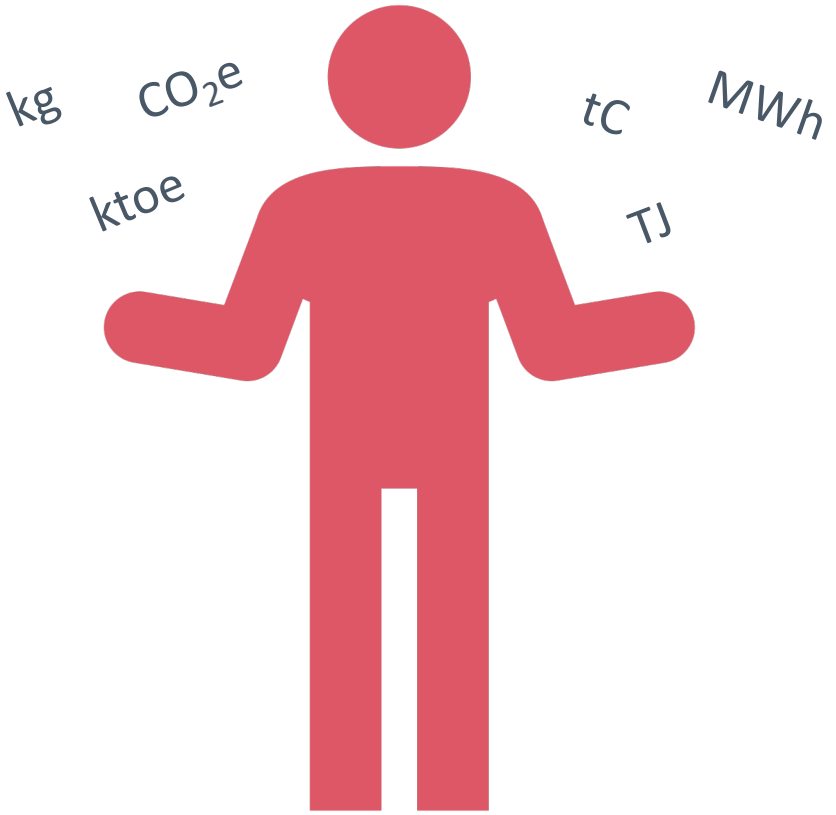
Activity data and emission factor conversion

GHG emissions (tCO_2e)
= Activity data x emission factor

Activity data is in kilo tonnes of oil equivalent (**ktoe**)

Emission factors for CO_2 are in tonnes of carbon per terajoule (**tC/TJ**) or tonnes of carbon dioxide per Megawatt-hour (**tCO_2/MWh**)

Emission factors for CH_4 and N_2O are in kilograms per terajoule (**kg/TJ**)



Activity data and emission factor conversion

GHG emissions (tCO2e)
= Activity data (TJ)
x emission factor (tGHG/TJ)
x GWP (tCO2e/tGHG)

- Convert activity data from ktoe to TJ
- Convert emission factors for CO_2 from tC/TJ to tCO_2/TJ
- Convert emission factors for CH_4 and N_2O from kg/TJ to t/TJ
- Convert tonnes of CH_4 and N_2O to CO_2e using GWP

Activity data and emission factor conversion

- Convert activity data from ktoe to TJ
- Convert emission factors for CO_2 from tC/TJ to tCO_2/TJ
- Convert emission factors for CH_4 and N_2O from kg/TJ to t/TJ
- Convert tonnes of CH_4 and N_2O to CO_2e using GWP

kilo tonnes oil equivalent (ktoe) > terajoules (TJ)

- Multiply by a conversion factor

ktoe	*	41.868	=	TJ

tC/TJ > tCO_2/TJ

- Multiply by molecular weight ratio (44/12)

tC/TJ	*	44/12	=	tCO_2/TJ

$kgCH_4$/TJ > tCO_2e/TJ

- Divide by 1,000 and multiply by GWP

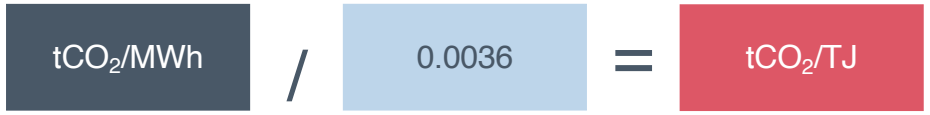
$kgCH_4$/TJ	/	1000	*	GWP (25)	=	tCO_2e/TJ
kgN_2O/TJ	/	1000	*	GWP (298)	=	tCO_2e/TJ

Electricity emission factor conversion

- Convert emission factors for CO_2 from tCO_2/MWh to tCO_2/TJ

tCO_2/MWh > tCO_2/TJ

- Divide by a conversion factor



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)

Task 3: Stationary energy

Table		Steps
1a	Find activity data and convert to TJ	Demonstration: Natural gas use in Commercial & Institutional sub-sector (I.2)
1b	Identify scaling factor and scale data to city boundary	
1c	Find emission factors and convert to tGHG/TJ	
1d	Estimate GHG emissions	

Task 3: Stationary energy

Cell | *fx*

Module C: Stationary Energy

1. Estimate scope 1 and 2 GHG emissions for Residential (I.1), Commercial & Institutional (I.2) and Manufacturing industry (I.3)

1a. Identify activity data from data provided in Table 29 of the National Energy Balance 2017

Fuel type	I.1 Residential		I.2 Commercial & Institutional		I.3 Manufacturing industry	
	ktoe	Convert to TJ	ktoe	Convert to TJ	ktoe	Convert to TJ
Natural gas						
LPG						
Kerosene						
Petrol						
Diesel						
Fuel oil						
Coal & Coke						
Electrcity						

1a. Record activity data (NEB 2017)

E10	*fx*	= 25

Module C: Stationary Energy

1. Estimate scope 1 and 2 GHG emissions for Residential (I.1), Commercial & Institutional (I.2) and Manufacturing industry (I.3)

1a. Identify activity data from data provided in Table 29 of the National Energy Balance 2017

Fuel type	I.1 Residential		I.2 Commercial & Institutional		I.3 Manufacturing industry	
	ktoe	Convert to TJ	ktoe	Convert to TJ	ktoe	Convert to TJ
Natural gas			25			
LPG						
Kerosene						
Petrol						
Diesel						
Fuel oil						
Coal & Coke						
Electrcity						

1a. Convert ktoe to TJ

F10	*fx*	= E10 * 41.868

Module C: Stationary Energy

1. Estimate scope 1 and 2 GHG emissions for Residential (I.1), Commercial & Institutional (I.2) and Manufacturing industry (I.3)

1a. Identify activity data from data provided in Table 29 of the National Energy Balance 2017

Fuel type	I.1 Residential		I.2 Commercial & Institutional		I.3 Manufacturing industry	
	ktoe	Convert to TJ	ktoe	Convert to TJ	ktoe	Convert to TJ
Natural gas			25	1047		
LPG						
Kerosene						
Petrol						
Diesel						
Fuel oil						
Coal & Coke						
Electrcity						

1b. Copy activity data from 1a

C34	*fx*	= F10

1b. Identify suitable scaling factor and scale data to city boundary

I.1 Residential

Fuel type	National	Scaling factor				City
	Activity data (TJ)	Scaling factor	National value	City value	Ratio (city/national)	Activity data (TJ)
Natural gas						
LPG						
Kerosene						
Electricity						

I.2 Commercial & Institutional

Fuel type	National	Scaling factor				City
	Activity data (TJ)	Scaling factor	National value	City value	Ratio (city/national)	Activity data (TJ)
Natural gas	1047					
LPG						
Diesel						

1b. Select scaling factor

D34	*fx*	= GDP

1b. Identify suitable scaling factor and scale data to city boundary

I.1 Residential

Fuel type	National	Scaling factor				City
	Activity data (TJ)	Scaling factor	National value	City value	Ratio (city/national)	Activity data (TJ)
Natural gas						
LPG						
Kerosene						
Electricity						

I.2 Commercial & Institutional

Fuel type	National	Scaling factor				City
	Activity data (TJ)	Scaling factor	National value	City value	Ratio (city/national)	Activity data (TJ)
Natural gas	1047	GDP				
LPG						
Diesel						

1b. Copy national value (BUR3)

E34	*fx*	= 1108900

1b. Identify suitable scaling factor and scale data to city boundary

I.1 Residential

Fuel type	National	Scaling factor				City
	Activity data (TJ)	Scaling factor	National value	City value	Ratio (city/national)	Activity data (TJ)
Natural gas						
LPG						
Kerosene						
Electricity						

I.2 Commercial & Institutional

Fuel type	National	Scaling factor				City
	Activity data (TJ)	Scaling factor	National value	City value	Ratio (city/national)	Activity data (TJ)
Natural gas	1047	GDP	1108900			
LPG						
Diesel						

1b. Copy city value

F34	*fx*	= 52097/0,24

1b. Identify suitable scaling factor and scale data to city boundary

I.1 Residential

Fuel type	National	Scaling factor				City
	Activity data (TJ)	Scaling factor	National value	City value	Ratio (city/national)	Activity data (TJ)
Natural gas						
LPG						
Kerosene						
Electricity						

I.2 Commercial & Institutional

Fuel type	National	Scaling factor				City
	Activity data (TJ)	Scaling factor	National value	City value	Ratio (city/national)	Activity data (TJ)
Natural gas	1047	GDP	1108900	217071		
LPG						
Diesel						

1b. Estimate ratio

G34	*fx*	= F34/E34

1b. Identify suitable scaling factor and scale data to city boundary

I.1 Residential

Fuel type	National	Scaling factor				City
	Activity data (TJ)	Scaling factor	National value	City value	Ratio (city/national)	Activity data (TJ)
Natural gas						
LPG						
Kerosene						
Electricity						

I.2 Commercial & Institutional

Fuel type	National	Scaling factor				City
	Activity data (TJ)	Scaling factor	National value	City value	Ratio (city/national)	Activity data (TJ)
Natural gas	1047	GDP	1108900	217071	0.20	
LPG						
Diesel						

1b. Apply ratio to scale activity data

H34	*fx*	= C34*G34

1b. Identify suitable scaling factor and scale data to city boundary

I.1 Residential

Fuel type	National	Scaling factor				City
	Activity data (TJ)	Scaling factor	National value	City value	Ratio (city/national)	Activity data (TJ)
Natural gas						
LPG						
Kerosene						
Electricity						

I.2 Commercial & Institutional

Fuel type	National	Scaling factor				City
	Activity data (TJ)	Scaling factor	National value	City value	Ratio (city/national)	Activity data (TJ)
Natural gas	1047	GDP	1108900	217071	0.20	205
LPG						
Diesel						

1c. Copy emission factor: CO_2 (BUR3)

C56	*fx*	= 15.3

1c. Identify emission factors from data provided in Table A2 of the Third Biennial Update Report to the the UNFCCC

Fuel type	CO2 (tC/TJ)	Convert to tCOe/TJ	CH4 (kg/TJ)	Convert to tCH4/TJ	N2O (kg/TJ)	Convert to tN2O/TJ
Natural gas	15.3					
LPG						
Kerosene						
Petrol						
Diesel						
Fuel oil						
Coal & Coke						
Electrcity						

1c. Copy emission factor: CH_4 (BUR3)

E56	*fx*	= 1

1c. Identify emission factors from data provided in Table A2 of the Third Biennial Update Report to the the UNFCCC

Fuel type	CO2 (tC/TJ)	Convert to tCOe/TJ	CH4 (kg/TJ)	Convert to tCH4/TJ	N2O (kg/TJ)	Convert to tN2O/TJ
Natural gas	15.3		1			
LPG						
Kerosene						
Petrol						
Diesel						
Fuel oil						
Coal & Coke						
Electrcity						

1c. Copy emission factor: N_2O (BUR3)

G56	*fx*	= 0.1

1c. Identify emission factors from data provided in Table A2 of the Third Biennial Update Report to the the UNFCCC

Fuel type	CO2 (tC/TJ)	Convert to tCOe/TJ	CH4 (kg/TJ)	Convert to tCH4/TJ	N2O (kg/TJ)	Convert to tN2O/TJ
Natural gas	15.3		1		0.1	
LPG						
Kerosene						
Petrol						
Diesel						
Fuel oil						
Coal & Coke						
Electrcity						

1c. Convert tC/TJ to tCO_2/TJ

D56	*fx*	= C56*(44/12)

1c. Identify emission factors from data provided in Table A2 of the Third Biennial Update Report to the the UNFCCC

Fuel type	CO2 (tC/TJ)	Convert to tCOe/TJ	CH4 (kg/TJ)	Convert to tCH4/TJ	N2O (kg/TJ)	Convert to tN2O/TJ
Natural gas	15.3	56.1	1		0.1	
LPG						
Kerosene						
Petrol						
Diesel						
Fuel oil						
Coal & Coke						
Electrcity						

1c. Convert $kgCH_4/TJ$ to tCH_4/TJ

F56	*fx*	= E56/1000

1c. Identify emission factors from data provided in Table A2 of the Third Biennial Update Report to the the UNFCCC

Fuel type	CO2 (tC/TJ)	Convert to tCOe/TJ	CH4 (kg/TJ)	Convert to tCH4/TJ	N2O (kg/TJ)	Convert to tN2O/TJ
Natural gas	15.3	56.1	1	0.001	0.1	
LPG						
Kerosene						
Petrol						
Diesel						
Fuel oil						
Coal & Coke						
Electrcity						

1c. Convert kgCH_4/TJ to tCH_4/TJ

H56	*fx*	= G56/1000

1c. Identify emission factors from data provided in Table A2 of the Third Biennial Update Report to the the UNFCCC

Fuel type	CO2 (tC/TJ)	Convert to tCOe/TJ	CH4 (kg/TJ)	Convert to tCH4/TJ	N2O (kg/TJ)	Convert to tN2O/TJ
Natural gas	15.3	56.1	1	0.001	0.1	0.0001
LPG						
Kerosene						
Petrol						
Diesel						
Fuel oil						
Coal & Coke						
Electrcity						

1c. Electricity emission factor

D63	*fx*	= ### / 0.0036

1c. Identify emission factors from data provided in Table A2 of the Third Biennial Update Report to the the UNFCCC

Fuel type	CO2 (tC/TJ)	Convert to tCOe/TJ	CH4 (kg/TJ)	Convert to tCH4/TJ	N2O (kg/TJ)	Convert to tN2O/TJ
Natural gas						
LPG						
Kerosene						
Petrol						
Diesel						
Fuel oil						
Coal & Coke						
Electrcity						

Data not available

1d: Multiply activity data (1b) by EF (1c)

C80	*fx*	= H34*D56

1d. Calculate GHG emission

I.1 Residential

Fuel type	CO2	CH4		N2O		Total
	tCO2e	tCH4	tCO2e	tN2O	tCO2e	tCO2e
Natural gas						
LPG						
Kerosene						
Electricity						

I.2 Commercial & Institutional

Fuel type	CO2	CH4		N2O		Total
	tCO2e	tCH4	tCO2e	tN2O	tCO2e	tCO2e
Natural gas	11495					
LPG						
Diesel						

1d: Multiply activity data (1b) by EF (1c)

D80	*fx*	= H34*F56

1d. Calculate GHG emission

I.1 Residential

Fuel type	CO2	CH4		N2O		Total
	tCO2e	tCH4	tCO2e	tN2O	tCO2e	tCO2e
Natural gas						
LPG						
Kerosene						
Electricity						

I.2 Commercial & Institutional

Fuel type	CO2	CH4		N2O		Total
	tCO2e	tCH4	tCO2e	tN2O	tCO2e	tCO2e
Natural gas	11495	0.2				
LPG						
Diesel						

1d: Multiply activity data (1b) by EF (1c)

F80	*fx*	= H34*H56

1d. Calculate GHG emission

I.1 Residential

Fuel type	CO2	CH4		N2O		Total
	tCO2e	tCH4	tCO2e	tN2O	tCO2e	tCO2e
Natural gas						
LPG						
Kerosene						
Electricity						

I.2 Commercial & Institutional

Fuel type	CO2	CH4		N2O		Total
	tCO2e	tCH4	tCO2e	tN2O	tCO2e	tCO2e
Natural gas	11495	0.2		0.02		
LPG						
Diesel						

1d: Apply GWP factor to CH_4

E80	*fx*	= D80*25

1d. Calculate GHG emission

I.1 Residential

Fuel type	CO2	CH4		N2O		Total
	tCO2e	tCH4	tCO2e	tN2O	tCO2e	tCO2e
Natural gas						
LPG						
Kerosene						
Electricity						

I.2 Commercial & Institutional

Fuel type	CO2	CH4		N2O		Total
	tCO2e	tCH4	tCO2e	tN2O	tCO2e	tCO2e
Natural gas	11495	0.2	5.12	0.02		
LPG						
Diesel						

1d: Apply GWP factor to N_2O

G80	*fx*	= F80*298

1d. Calculate GHG emission

I.1 Residential

Fuel type	CO2	CH4		N2O		Total
	tCO2e	tCH4	tCO2e	tN2O	tCO2e	tCO2e
Natural gas						
LPG						
Kerosene						
Electricity						

I.2 Commercial & Institutional

Fuel type	CO2	CH4		N2O		Total
	tCO2e	tCH4	tCO2e	tN2O	tCO2e	tCO2e
Natural gas	11495	0.2	5.12	0.02	6.11	
LPG						
Diesel						

1d: Sum all CO_2, CH_4 and N_2O emissions

H80	*fx*	= C80+E80+G80

1d. Calculate GHG emission

I.1 Residential

Fuel type	CO2	CH4		N2O		Total
	tCO2e	tCH4	tCO2e	tN2O	tCO2e	tCO2e
Natural gas						
LPG						
Kerosene						
Electricity						

I.2 Commercial & Institutional

Fuel type	CO2	CH4		N2O		Total
	tCO2e	tCH4	tCO2e	tN2O	tCO2e	tCO2e
Natural gas	11495	0.2	5.12	0.02	6.11	11506
LPG						
Diesel						

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)

Practical: Task #4

	Task	
1	Identify all sources of GHG emissions from energy use in buildings across your city: • What activities are taking place? • Where are the emissions occurring? List them in Table 1	10m
2	Determine what types of fuel are being used. Complete Table 2	10m
3	Estimate scope 1 and 2 GHG emissions for Residential (I.1), Commercial & Institutional (I.2) and Manufacturing industries (I.3) sub-sectors using national fuel use data	30m
4	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”.	10m
5	Consolidate the above 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	15m

Workbook: Task #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

Workbook: Task #4

Figure 2 Sources and scopes covered by the GPC

Sectors and sub-sectors	Scope 1	Scope 2	Scope 3
STATIONARY ENERGY			
Residential buildings	✓	✓	✓
Commercial and institutional buildings and facilities	✓	✓	✓
Manufacturing industries and construction	✓	✓	✓
Energy industries	✓	✓	✓
Energy generation supplied to the grid	✓		
Agriculture, forestry, and fishing activities	✓	✓	✓
Non-specified sources	✓	✓	✓
Fugitive emissions from mining, processing, storage, and transportation of coal	✓		
Fugitive emissions from oil and natural gas systems	✓		
TRANSPORTATION			
On-road	✓	✓	✓
Railways	✓	✓	✓
Waterborne navigation	✓	✓	✓
Aviation	✓	✓	✓
Off-road	✓	✓	
WASTE			
Disposal of solid waste generated in the city	✓		✓
Disposal of solid waste generated outside the city	✓		
Biological treatment of waste generated in the city	✓		✓
Biological treatment of waste generated outside the city	✓		
Incineration and open burning of waste generated in the city	✓		✓
Incineration and open burning of waste generated outside the city	✓		
Wastewater generated in the city	✓		✓
Wastewater generated outside the city	✓		
INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)			
Industrial processes	✓		
Product use	✓		
AGRICULTURE, FORESTRY AND OTHER LAND USE (AFOLU)			
Livestock	✓		
Land	✓		
Aggregate sources and non-CO_2 emission sources on land	✓		
OTHER SCOPE 3			
Other Scope 3			

✓ Sources covered by the GPC

+ Sources required for BASIC+ reporting

Sources included in Other Scope 3

Sources required for BASIC reporting

Sources required for territorial total but not for BASIC/BASIC+ reporting (*italics*)

Non-applicable emissions

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			

Fugitive emissions (I.8)

CIRIS tool can be used to estimate fugitive emissions

Applies emission factors for CO_2 and CH_4 to gas consumption in a city

Assume fugitive emissions are negligible (ie insignificant). We will revisit and update this in Module G

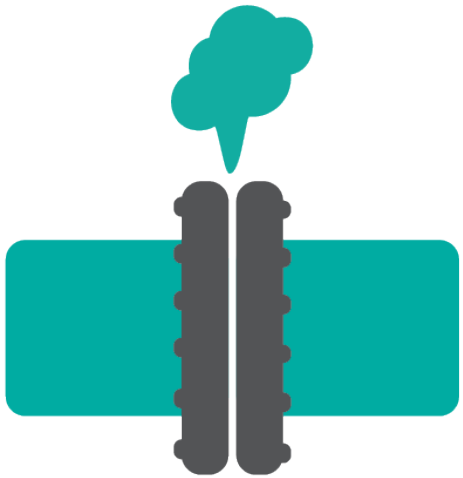


Table 3: GPC table

Sub-sector		Scope 1	Scope 2	Scope 3
I.1	Residential buildings	1,459,920 tCO2e	2,289,200 tCO2e	NE
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			

Task 4:

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”.

Congratulations

Practical

	Task	
1	Identify all sources of GHG emissions from energy use in buildings across your city: • What activities are taking place? • Where are the emissions occurring? List them in Table 1	10m
2	Determine what types of fuel are being used. Complete Table 2	10m
3	Estimate scope 1 and 2 GHG emissions for Residential (I.1), Commercial & Institutional (I.2) and Manufacturing industries (I.3) sub-sectors using national fuel use data	30m
4	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”.	10m
5	Consolidate the above 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	15m

Workbook: Task #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

Workbook: Task #4

Table 4: Action plan

Stationary energy

Sub-sector	Data / action	Where from?	Action	Lead

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				

Table 4: Action plan

GPC	Data	Where from?	Action	Lead
Residential buildings	Obtain electricity use data	Ministry for the Environment	Request informal meeting to discuss what data they have	Mrs. Jones (Dept of Energy)
Commercial buildings and facilities				
Institutional buildings and facilities				
Manufacturing / construction				
Energy generation supplied to the grid				
Fugitive emissions from oil and gas				

Task 5:

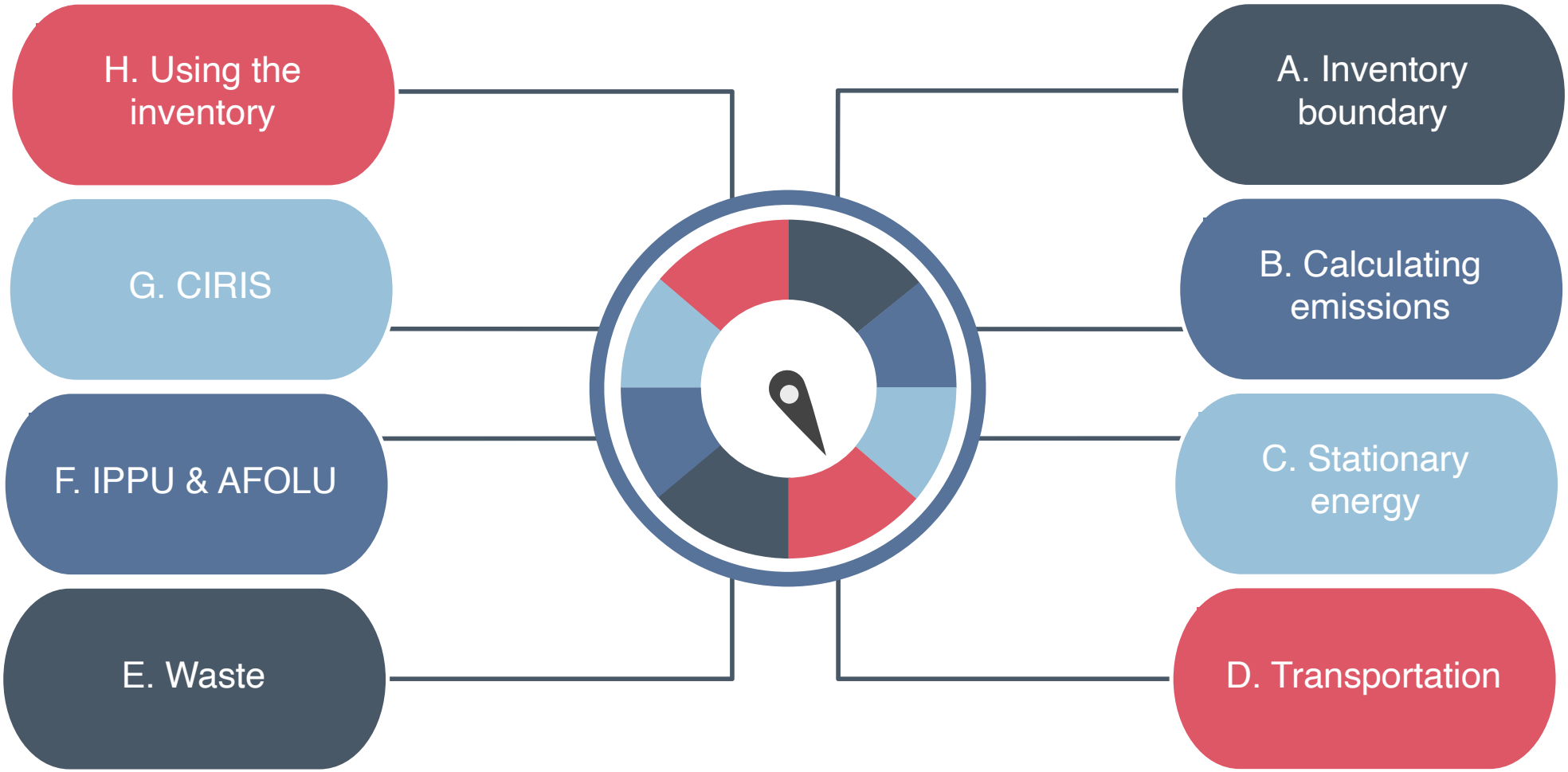
Consolidate the above information into Table 4 and identify what activity data and emission factors you will need to estimate GHG emissions, and where you will source this from

03
SUMMARY

Module 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		


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: Transporation