



GHG Inventory: Mobile combustion- Water Borne Navigation

Training on 2006 IPCC Guidelines for preparing National GHG Inventory:

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*Organized by the Capacity Building Initiative for
Transparency
Global Support Programme (CBIT-GSP)*

Content

Water-borne navigation coverage in
2006 IPCC guideline

Calculation examples and exercises –
Manually & using IPCC inventory tool



Emission source coverage for civil aviation

Emissions from fuels used to propel water-borne vessels, including hovercraft and hydrofoils, but **excluding fishing vessels**. The international/domestic split should be determined on the **basis of port of departure and port of arrival**, and **not by the flag or nationality of the ship**.

- According to the 2006 IPCC Guidelines it may include emissions from,
 - **International water-borne navigation (International bunkers)**
 - Emissions from fuels used by vessels of all flags that are engaged in international water-borne navigation.
 - Take place at sea, on inland lakes and waterways and in coastal waters.
 - Includes emissions from journeys that depart in one country and arrive in a different country.
 - Exclude consumption by fishing vessels

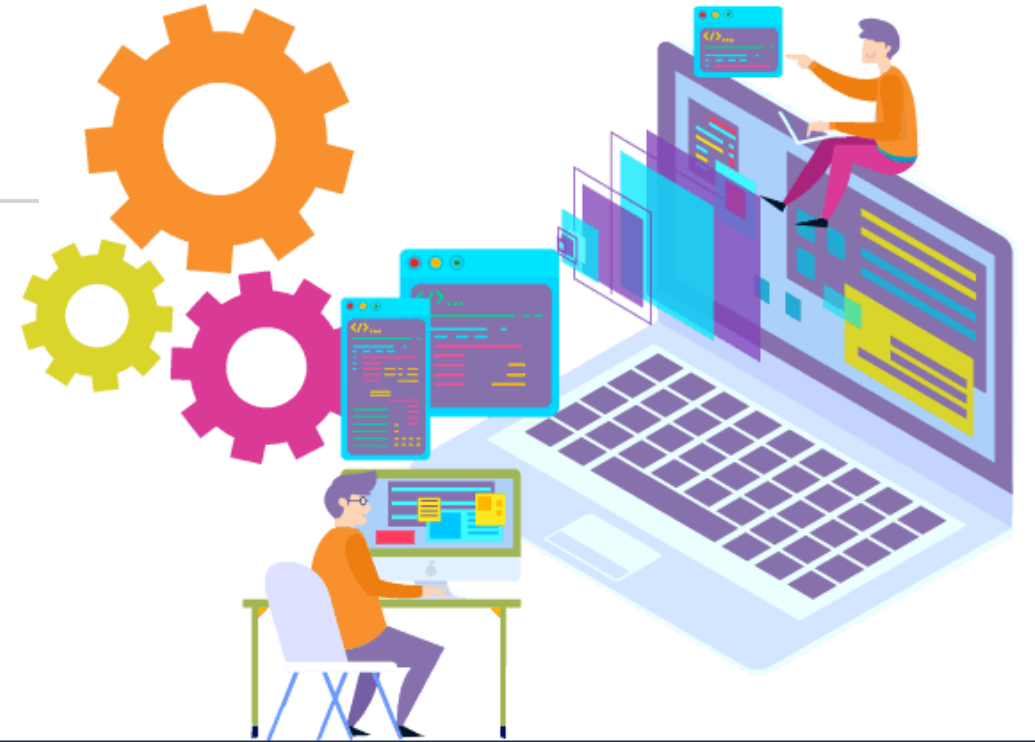


- Domestic water-borne navigation

- Emissions from fuels used by vessels of all flags that depart and arrive in the same country
- Exclude consumption by fishing vessels



Calculation examples and exercises – Manually & using IPCC inventory tool



Flow of the presentation

- Each sub-category contain an example and corresponding exercise to be done by you
- Sub-categories with same worksheet formats have only one example and exercise



- Two methodological tiers for estimating emissions of CO₂, CH₄, and N₂O

Tier 1	• Apply either default values or country-specific information
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Water-borne navigation equation

$$\text{Emission} = \sum [\text{Fuel Consumed}_{ab} * \text{Emission Factor}_{ab}]$$

Parameter	Description	Unit
Emission	Emissions of CO ₂ , CH ₄ , N ₂ O	kg
a	Fuel type e (diesel, gasoline, LPG, bunker, etc.)	N/A
b	Water-borne navigation type (i.e., Ship or boat, and possibly engine type.) (Only at tier 2 is the fuel used differentiated by type of vessel so, b can be ignored at tier 1)	N/A

Default EF can be
 obtained from 2006
 IPCC guideline >>
 Volume 2 >>
 Chapter 3

Calculation example to find emissions from water-borne navigation in Philippines 2010, tier 1

2006, IPCC default EF

Fuel type	Consumption (ktoe)	2006 IPCC default emission factor (kg/TJ)			Conversion factor (TJ/ ktoe)
		CO ₂	CH ₄	N ₂ O	
Regular Gasoline	78.16	69300	7	2	41.87
Diesel	382.89	74100	7	2	41.87
Fuel oil	916.75	77400	7	2	41.87

TABLE 3.5.2
CO₂ EMISSION FACTORS

Fuel	kg/TJ			
	Default	Lower	Upper	
Gasoline	69 300	67 500	73 000	
Other Kerosene	71 900	70 800	73 600	
Gas/Diesel Oil	74 100	72 600	74 800	
Residual Fuel Oil	77 400	75 500	78 800	
Liquefied Petroleum Gases	63 100	61 600	65 600	
Other Oil	Refinery Gas	57 600	48 200	69 000
	Paraffin Waxes	73 300	72 200	74 400
	White Spirit & SBP	73 300	72 200	74 400
	Other Petroleum Products	73 300	72 200	74 400
Natural Gas	56 100	54 300	58 300	

*conversion factor is used in here because activity data was given in ktoe (kilometre tonne of oil equivalents)

Fuel type	Emissions = Fuel consumption * EF		
	CO ₂	CH ₄	N ₂ O
Regular Gasoline	Fuel consumption = 78.16 ktoe * 41.87 TJ/ ktoe = 3,272.5592 TJ E _{CO2} = 3,272.5592 TJ * 69300 kg/TJ = 226788352.6 kg or 226.79 Gg	22907.9144 kg or 0.023 Gg	6545.1184 kg or 6.55*10 ⁻³ Gg



Let's start working with
the software



Dive into the Inventory
tool together and
explore its features
firsthand



Open the software and
go to worksheets!

IPCC Inventory Software - dinukshi@climatesi - [Worksheets]

Application Database Inventory Year Administrate Worksheets Tools Export/Import Reports Window Help

2006 IPCC Categories

- 1 - Energy
- 2 - Industrial Processes and Product Use
- 3 - Agriculture, Forestry, and Other Land Use
- 4 - Waste
- 5 - Other

Time Series

Time Series

Category 1 - Energy

Gas CARBON DIOXIDE (CO2)

CARBON DIOXIDE (CO2) Emissions (Gg CO2 Equivalents)

*1... 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

* Base year for assessment of uncertainty in trend: 1990

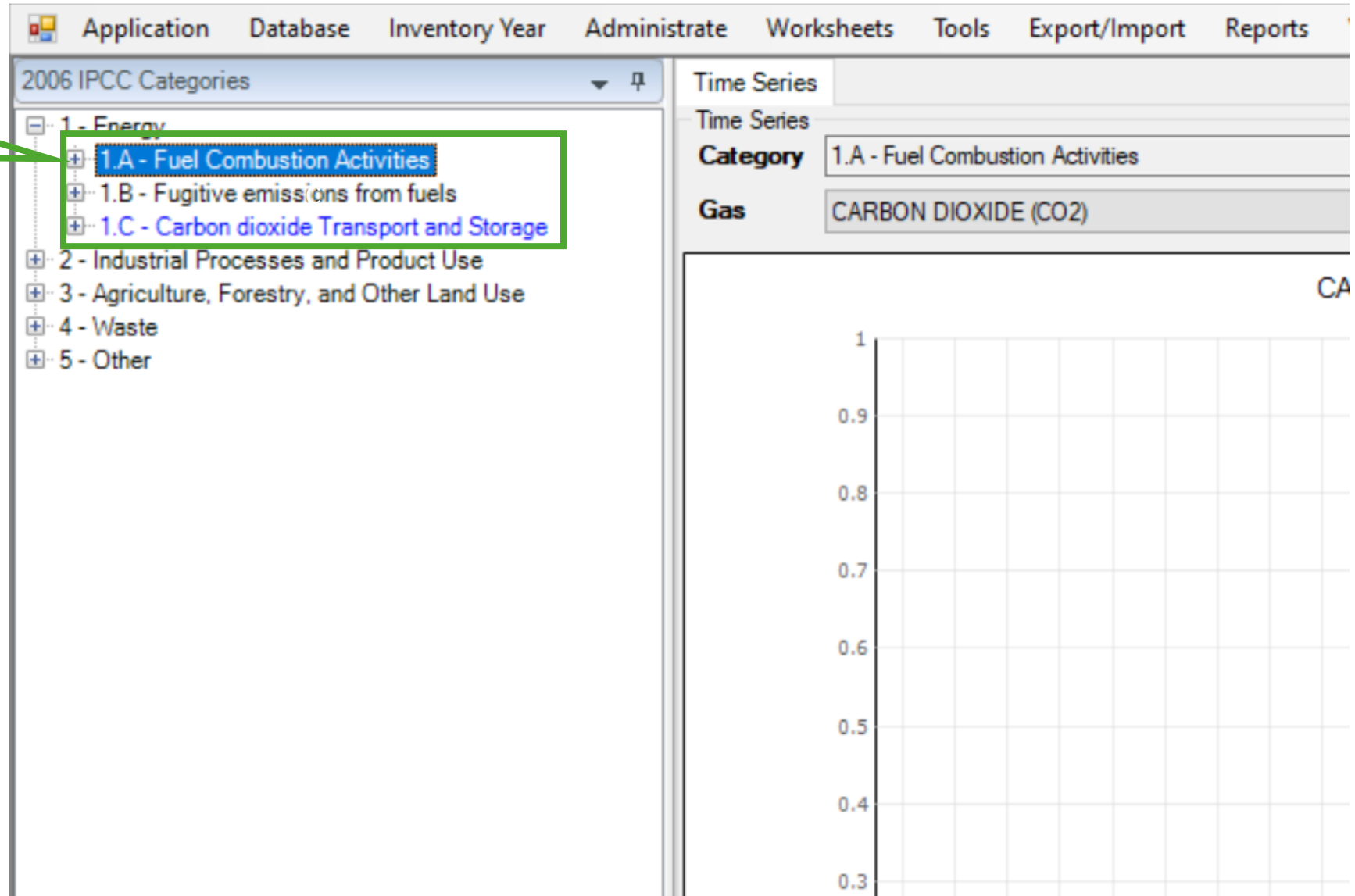
Select the sector that you want to enter data

In here select the sector as 'Energy'

Then, click on the '+' mark in front of the Energy sector

You will be getting categories of Energy sector

IPCC Inventory Software - dinukshi@climatesi - [Worksheets]



The screenshot shows the IPCC Inventory Software interface. The main window displays a tree view of the 2006 IPCC Categories. The '1 - Energy' category is expanded, showing three sub-categories: '1.A - Fuel Combustion Activities', '1.B - Fugitive emissions from fuels', and '1.C - Carbon dioxide Transport and Storage'. The '1.A - Fuel Combustion Activities' category is highlighted with a green box. To the right of the tree view, there is a 'Time Series' panel. The 'Category' field is set to '1.A - Fuel Combustion Activities' and the 'Gas' field is set to 'CARBON DIOXIDE (CO2)'. Below the 'Time Series' panel, there is a chart area with a vertical axis ranging from 0.3 to 1.0 and a horizontal axis labeled 'CA'.

There are 3 categories of Energy sector

To enter mobile combustion data, click on '+' mark in front of '1.A - Fuel combustion activities' and proceed

Application Database Inventory Year Administrate Worksheets Tools Export/Import Reports Window Help

2006 IPCC Categories

- 1.A.2.f - Non-Metallic Minerals
- 1.A.2.g - Transport Equipment
- 1.A.2.h - Machinery
- 1.A.2.i - Mining (excluding fuels) and Quar
- 1.A.2.j - Wood and wood products
- 1.A.2.k - Construction
- 1.A.2.l - Textile and Leather
- 1.A.2.m - Non-specified Industry
- 1.A.3 - Transport
 - 1.A.3.a - Civil Aviation
 - 1.A.3.a.i - International Aviation (Intern
 - 1.A.3.a.ii - Domestic Aviation
 - 1.A.3.b - Road Transportation
 - 1.A.3.b.i - Cars
 - 1.A.3.b.i.1 - Passenger cars with 3
 - 1.A.3.b.i.2 - Passenger cars without
 - 1.A.3.b.ii - Light-duty trucks
 - 1.A.3.b.ii.1 - Light-duty trucks with
 - 1.A.3.b.ii.2 - Light-duty trucks with
 - 1.A.3.b.iii - Heavy-duty trucks and bus
 - 1.A.3.b.iv - Motorcycles
 - 1.A.3.b.v - Evaporative emissions from
 - 1.A.3.b.vi - Urea-based catalysts
 - 1.A.3.c - Railways
 - 1.A.3.d - Water-borne Navigation
 - 1.A.3.d.i - International water-borne na
 - 1.A.3.d.ii - Domestic Water-borne Navi
 - 1.A.3.e - Other Transportation
 - 1.A.3.e.i - Pipeline Transport
 - 1.A.3.e.ii - Off-road
- 1.A.4 - Agriculture/Forestry/Fishing/Fi
 - 1.A.4.c - Agriculture/Forestry/Fishing/Fi
 - 1.A.4.c.ii - Off-road Vehicles and Ot
 - 1.A.4.c.iii - Fishing (mobile combusti
 - 1.A.5 - Non-Specified
 - 1.A.5.b - Mobile
 - 1.A.5.b.i - Mobile (aviation compone
 - 1.A.5.b.ii - Mobile (water-borne com
 - 1.A.5.b.iii - Mobile (Other)
 - 1.A.5.c - Multilateral Operations

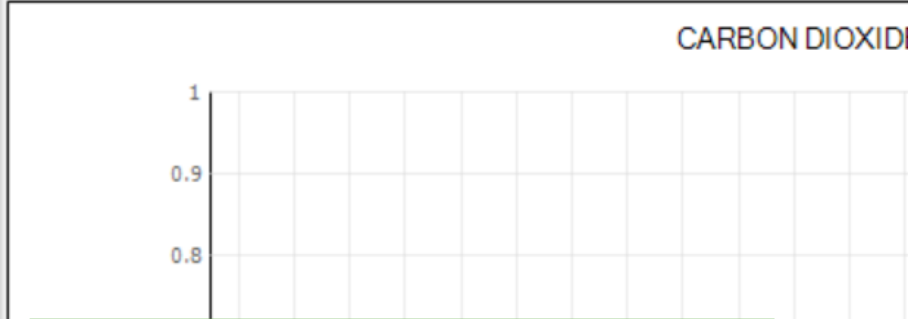
Mobile combustion related categories and sub-categories

1.A.4.c - Agriculture/Forestry/Fishing/Fi

- 1.A.4.c.ii - Off-road Vehicles and Ot
- 1.A.4.c.iii - Fishing (mobile combusti

1.A.5 - Non-Specified

- 1.A.5.b - Mobile
 - 1.A.5.b.i - Mobile (aviation compone
 - 1.A.5.b.ii - Mobile (water-borne com
 - 1.A.5.b.iii - Mobile (Other)
- 1.A.5.c - Multilateral Operations



1.A.3.d – Water-borne navigation

- Worksheets have same formats for sub-categories *1.A.3.d.i – International water-borne navigation (International bunkers)* and *1.A.3.d.ii – Domestic water-borne navigation*
 - There are 2 worksheets in each sub-category
 1. Fuel consumption data
 2. Fuel combustion emissions

006 IPCC Categories

- 1.A.2.g - Transport Equipment
- 1.A.2.h - Machinery
- 1.A.2.i - Mining (excluding fuels) and Q
- 1.A.2.j - Wood and wood products
- 1.A.2.k - Construction
- 1.A.2.l - Textile and Leather
- 1.A.2.m - Non-specified Industry
- 1.A.3 - Transport
 - 1.A.3.a - Civil Aviation
 - 1.A.3.a.i - International Aviation (Int)
 - 1.A.3.a.ii - Domestic Aviation
 - 1.A.3.b - Road Transportation
 - 1.A.3.b.i - Cars
 - 1.A.3.b.i.1 - Passenger cars wit
 - 1.A.3.b.i.2 - Passenger cars wit
 - 1.A.3.b.ii - Light-duty trucks
 - 1.A.3.b.ii.1 - Light-duty trucks wi
 - 1.A.3.b.ii.2 - Light-duty trucks wi
 - 1.A.3.b.iii - Heavy-duty trucks and b
 - 1.A.3.b.iv - Motorcycles

Fuel Consumption Data

Fuel Combustion Emissions

Worksheet

Sector: Energy

Category: Fuel Combustion Activities

Subcategory: 1.A.3.d.i - International water-borne navigation (International bunkers)

Sheet: Fuel Consumption Data

Data

Fuel Type Liquid Fuels

2020

Equation 3.5.1							
Subdivision	Fuel	Vessel and Engine type	Consumption (Mass, Volume or Energy Unit)	Consumption Unit	Conversion Factor (TJ/Unit) (NCV)	Total consumption (TJ)	
S	F		C	U	CF	TC = C * CF	
W1	Gas/Diesel Oil	Boat	2500	Gg (Auto CF)	43	107500	
Total						107500	

1. Fuel consumption data

Select the 'fuel'

Select the 'fuel type'

Fuel Name	Net Calorific Value (TJ / Gg)	Carbon content (NCV) (kg C / GJ)
Aviation Gasoline	44.3	19.1
Bitumen	40.2	22
Crude Oil	42.3	20
Ethane	46.4	16.8
Gas/Diesel Oil	43	20.2
Jet Gasoline	44.3	19.1
Jet Kerosene	44.1	19.5
Liquefied Petroleum Gases	47.3	17.2

Click 'save' button finally to save the information you entered

User-defined parameter

Default or user-defined parameter

The user must enter this information accordingly

Gg (Auto CF)
Gg (Manual CF)
TJ

- 2006 IPCC Categories
 - 1.A.3.c - Railways
 - 1.A.3.d - Water-borne Navigation
 - 1.A.3.d.i - International water-borne navigation**
 - 1.A.3.d.ii - Domestic Water-borne Navigation
 - 1.A.3.e - Other Transportation
 - 1.A.3.e.i - Pipeline Transport
 - 1.A.3.e.ii - Off-road
 - 4 - Other Sectors
 - 1.A.4.a - Commercial/Institutional
 - 1.A.4.b - Residential
 - 1.A.4.c - Agriculture/Forestry/Fishing/Fish
 - 1.A.4.c.i - Stationary
 - 1.A.4.c.ii - Off-road Vehicles and Other
 - 1.A.4.c.iii - Fishing (mobile combustion)
 - 5 - Non-Specified
 - 1.A.5.a - Stationary
 - 1.A.5.b - Mobile
 - 1.A.5.b.i - Mobile (aviation component)
 - 1.A.5.b.ii - Mobile (water-borne component)
 - 1.A.5.b.iii - Mobile (Other)
 - 1.A.5.c - Multilateral Operations

Fuel Consumption Data | Fuel Combustion Emissions

Worksheet

Sector: Energy

Category: Fuel Combustion Activities

Subcategory: 1.A.3.d.i - International water-borne navigation (International bunkers)

Sheet: Fuel Consumption Data

Data

Fuel Type: Liquid Fuels

2000

Equation 3.5.1

Subdivision	Fuel	Vessel and Engine type	Consumption (Mass, Volume or Energy Unit)	Consumption Unit	Conversion Factor (TJ/Unit) (NCV)	Total consumption (TJ)
S	F		C	U	CF	TC = C * CF
All	Gas/Diesel Oil	Passenger vessel	16031.6043	TJ	1	16031.6043
All	Motor Gasoline	Passenger vessel	3272.5592	TJ	1	3272.5592
All	Residual Fuel Oil	Passenger vehicle	38384.3225	TJ	1	38384.3225
Total						57688.486

2. Fuel combustion emissions

Select the 'fuel type'

Fuel Type (All fuels) ▾

- (All fuels)
- Liquid Fuels
- Solid Fuels
- Gaseous Fuels
- Other Fossil Fuels
- Biomass - solid
- Biomass - liquid
- Biomass - gas
- Biomass - other

Vehicle

Consumption Data Fuel Combustion Emissions

1.A.3.d - Water-borne Navigation

- 1.A.3.d.i - International water-borne n
- 1.A.3.d.ii - Domestic Water-borne Nav

1.A.3.e - Other Transportation

- 1.A.3.e.i - Pipeline Transport
- 1.A.3.e.ii - Off-road

4 - Other Sectors

- 1.A.4.a - Commercial/Institutional
- 1.A.4.b - Residential
- 1.A.4.c - Agriculture/Forestry/Fishing/Fish
- 1.A.4.c.i - Stationary
- 1.A.4.c.ii - Off-road Vehicles and Othe
- 1.A.4.c.iii - Fishing (mobile combustio

5 - Non-Specified

- 1.A.5.a - Stationary
- 1.A.5.b - Mobile
- 1.A.5.b.i - Mobile (aviation component
- 1.A.5.b.ii - Mobile (water-borne comp
- 1.A.5.b.iii - Mobile (Other)
- 1.A.5.c - Multilateral Operations

Uncertainties by Fuel Type

Liquid Fuels

Category: 1.A.3.d.i - International water-borne navigation (International bunkers)

Sheet: Fuel Combustion Emissions

Activity Data Uncertainties

Lower: -5.00 % Upper: +5.00 %

Emission Factors Uncertainties

Gas: CARBON DIOXIDE (CO2)

Lower: -3.53 % Upper: +4.30 %

OK Cancel

Enter uncertainties for activity data and emission factors of each gas (CH₄, CO₂, N₂O)

User-defined or default parameters

Click 'save' button finally to save the information you entered

Sector: Energy

Category: Fuel Combustion Activities

Subcategory: 1.A.3.d.i - International water-borne navigation (International bunkers)

Sheet: Fuel Combustion Emissions

Data

Fuel Type: Liquid Fuels

Uncertainties for Liquid Fuels

Equation 3.5.1

Fuel consumption				CO2			CH4		N2O	
Subdivision	Fuel	Vessel and Engine type	Total fuel consumption (TJ)	CO2 Emission Factor (kg CO2/TJ)	Amount Captured (Gg CO2)	CO2 Emissions (Gg CO2)	CH4 Emission Factor (kg CH4/TJ)	CH4 Emissions (Gg CH4)	N2O Emission Factor (kg N2O/TJ)	N2O Emissions (Gg N2O)
S	F	VT	C	EF(CO2)	Z	CO2=C*EF (CO2)/10^6-Z	EF(CH4)	CH4=C*EF (CH4)/10^6	EF(N2O)	N2O=C*EF (N2O)/10^6
All	Gas/Diesel Oil	Passenger ves...	16031.6043	74100	0	1187.94188	7	0.11222	2	0.03206
All	Motor Gasoline	Passenger ves...	3272.5592	69300	0	226.78835	7	0.02291	2	0.00655
All	Residual Fuel Oil	Passenger ve...	38384.3225	77400	0	2970.94656	7	0.26869	2	0.07677
Total			57688.486			4385.67679		0.40382		0.11538

User-defined parameter



Let's do an example with the
inventory tool!

Exercise 1: Water-borne navigation

Activity 01

Step 01: Open the worksheet fuel consumption data of either 1.A.3.d.i – International water-borne navigation (International bunkers) or 1.A.3.d.ii – Domestic water-borne navigation

Step 02: Select the fuel type as liquid fuels

Input parameter	Entry	Note
Subdivision	District A	
Fuel	Gas/ diesel oil	
Vessel and engine type	Boat	
Consumption	250 Gg (Auto CF)	

**the activity data used in this activity is not real. Just an assumption only for this activity.*

Step 03: Open the worksheet Fuel combustion emissions

Step 04: Select the fuel type as liquid fuels

Step 05: Open the dialog box for uncertainties for liquid fuels and enter following data accordingly

Entry parameter		Entry
Activity data uncertainties	Upper	+5.00%
	Lower	-5.00%
Emission factors uncertainties		
Select the gas as Carbon dioxide and enter following data <i>(*when you are entering data for real GHG inventory calculation, please make sure to enter uncertainties for other gases also)</i>		
	Upper	+4.30%
	Lower	-3.53%

**these values are not real. Just an example only for this activity.*

Step 06: Enter following data accordingly in the opened worksheet

Input parameter	Entry	Note
CO ₂ emission factor	Default value, 74100	You can use specific values also. But please use the default value for this activity.
Amount captured	0 (Zero)	
CH ₄ emission factor	Default value, 7	You can use specific values also. But please use the default value for this activity.
N ₂ O emission factor	Default value, 2	You can use specific values also. But please use the default value for this activity.

**the activity data used in this activity is not real. Just an example only for this activity.*

Step 07: Save entered data

Results



Fuel consumption data

Fuel Consumption Data | Fuel Combustion Emissions

Worksheet

Sector: Energy 2020

Category: Fuel Combustion Activities

Subcategory: 1.A.3.d.i - International water-borne navigation (International bunkers)

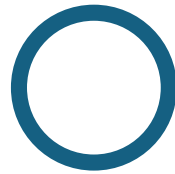
Sheet: Fuel Consumption Data

Data

Fuel Type Liquid Fuels

Equation 3.5.1

Subdivision	Fuel	Vessel and Engine type	Consumption (Mass, Volume or Energy Unit)	Consumption Unit	Conversion Factor (TJ/Unit) (NCV)	Total consumption (TJ)				
S	F		C	U	CF	TC = C * CF				
▶ District A	Gas/Diesel Oil	Boat	250	Gg (Auto CF)	43	10750				
* Total						10750				



Uncertainties for liquid fuels

Uncertainties by Fuel Type



Liquid Fuels

Category: 1.A.3.d.i - International water-borne navigation (International bunkers)

Sheet: Fuel Combustion Emissions

Activity Data Uncertainties

Lower	-5.00 %	Upper	+5.00 %
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Emission Factors Uncertainties

Gas: CARBON DIOXIDE (CO2)

Lower	-3.53 %	Upper	+4.30 %
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OK Cancel



Fuel combustion emissions

Fuel Consumption Data | Fuel Combustion Emissions

Worksheet

Sector: Energy 2020

Category: Fuel Combustion Activities

Subcategory: 1.A.3.d.i - International water-borne navigation (International bunkers)

Sheet: Fuel Combustion Emissions

Data

Fuel Type Liquid Fuels

Equation 3.5.1

Fuel consumption				CO2			CH4		N2O	
Subdivision	Fuel	Vessel and Engine type	Total fuel consumption (TJ)	CO2 Emission Factor (kg CO2/TJ)	Amount Captured (Gg CO2)	CO2 Emissions (Gg CO2)	CH4 Emission Factor (kg CH4/TJ)	CH4 Emissions (Gg CH4)	N2O Emission Factor (kg N2O/TJ)	N2O Emissions (Gg N2O)
S	F	VT	C	EF(CO2)	Z	$CO_2 = C * EF(CO_2) / 10^6 - Z$	EF(CH4)	$CH_4 = C * EF(CH_4) / 10^6$	EF(N2O)	$N_2O = C * EF(N_2O) / 10^6$
District A	Gas/Diesel Oil	Boat	10750	74100	0	796.575	7	0.07525	2	0.0215
Total			10750			796.575		0.07525		0.0215

OTHER TRANSPORTATION



- 1.A.3.e – Other transportation

- The worksheet format is different in 2 sub-categories *1.A.3.e.i – Pipeline transport* and *1.A.3.e.ii – Off-road*

Two worksheets in sub-category 1.A.3.e.i – Pipeline transport

- Fuel consumption data
- Fuel combustion emissions

Three worksheets in sub-category 1.A.3.e.ii – Off-road

- Fuel consumption data
- Fuel combustion emissions – Tier 1 and Tier 2
- Fuel combustion emissions – Tier 3

Fuel Consumption Data | Fuel Combustion Emissions

Worksheet

Sector: Energy
 Category: Fuel Combustion Activities
 Subcategory: 1.A.3.e.i - Pipeline Transport
 Sheet: Fuel Consumption Data

Data

Fuel Type: Liquid Fuels

Equation 2.4

Subdivision	Fuel
S	F
*	
Total	

Fuel Consumption Data | Fuel Combustion Emissions | Fuel Combustion Emissions - Tier 3

Worksheet

Sector: Energy
 Category: Fuel Combustion Activities
 Subcategory: 1.A.3.e.ii - Off-road
 Sheet: Fuel Consumption Data

Data

Fuel Type: Liquid Fuels

Equation 3.3.1, 3.3.2

Subdivision	Source	Fuel	Vehicle / Equipment	Consumption (Mass, Volume or Energy Unit)	Consumption Unit	Conversion Factor (TJ/Unit) (NCV)	Total consumption (TJ)
S	SRC	F		C	U	CF	TC = C * CF
*							
Total							0

1.A.3.e.i – Pipeline transport

1. Fuel consumption data

Select the 'fuel'

Select the 'fuel type'

Fuel Name	Net Calorific Value (TJ / Gg)	Carbon content (NCV) (kg C / GJ)
Aviation Gasoline	44.3	19.1
Bitumen	40.2	22
Crude Oil	42.3	20
Ethane	46.4	16.8
Gas/Diesel Oil	43	20.2
Jet Gasoline	44.3	19.1
Jet Kerosene	44.1	19.5
Liquefied Petroleum Gases	47.3	17.2

Fuel Type (All fuels) dropdown menu showing options: (All fuels), Liquid Fuels, Solid Fuels, Gaseous Fuels, Other Fossil Fuels, Biomass - solid, Biomass - liquid, Biomass - gas, Biomass - other.

Click 'save' button finally to save the information you entered

Default parameter

User-defined parameter

- 1.A.2.g - Transport Equipment
- 1.A.2.h - Machinery
- 1.A.2.i - Mining (excluding fuels) and Q
- 1.A.2.j - Wood and wood products
- 1.A.2.k - Construction
- 1.A.2.l - Textile and Leather
- 1.A.2.m - Non-specified Industry
- 1.A.3 - Transport
 - 1.A.3.a - Civil Aviation
 - 1.A.3.a.i - International Aviation (Int
 - 1.A.3.a.ii - Domestic Aviation
 - 1.A.3.b - Road Transportation
 - 1.A.3.b.i - Cars
 - 1.A.3.b.i.1 - Passenger cars wit
 - 1.A.3.b.i.2 - Passenger cars wit
 - 1.A.3.b.ii - Light-duty trucks
 - 1.A.3.b.ii.1 - Light-duty trucks wi
 - 1.A.3.b.ii.2 - Light-duty trucks wi
 - 1.A.3.b.iii - Heavy-duty trucks and b
 - 1.A.3.b.iv - Motorcycles

Fuel Consumption Data | Fuel Combustion Emissions | 2020

Sector: Energy
Category: Fuel Combustion Activities
Subcategory: 1.A.3.e.i - Pipeline Transport
Sheet: Fuel Consumption Data

Fuel Type: Liquid Fuels

Equation 2.4

Subdivision	Fuel	Consumption (Mass, Volume or Energy Unit)	Consumption Unit	Conversion Factor (TJ/Unit) (NCV)	Total consumption (TJ)
S	F	C	U	CF	TC = C * CF
Unspecified	Gas/Diesel Oil	700	Gg (Auto CF)	43	30100
Total					30100

2. Fuel combustion emissions

Select the 'fuel type'

Uncertainties by Fuel Type

Liquid Fuels

Category: 1.A.3.e.i - Pipeline Transport

Sheet: Fuel Combustion Emissions

Activity Data Uncertainties

Lower: -5.00 % Upper: +5.00 %

Emission Factors Uncertainties

Gas: CARBON DIOXIDE (CO2)

Lower: -5.00 % Upper: +5.00 %

OK Cancel

Enter uncertainties for activity data and emission factors of each gas (CH₄, CO₂, N₂O)

User-defined or default parameters

Click 'save' button finally to save the information you entered

Fuel Type (All fuels)

- (All fuels)
- Liquid Fuels
- Solid Fuels
- Gaseous Fuels
- Other Fossil Fuels
- Biomass - solid
- Biomass - liquid
- Biomass - gas
- Biomass - other

- PCC Categories
- 1.A.2.g - Transport Equipment
 - 1.A.2.h - Machinery
 - 1.A.2.i - Mining (excluding fuels) and Q
 - 1.A.2.j - Wood and wood products
 - 1.A.2.k - Construction
 - 1.A.2.l - Textile and Leather
 - 1.A.2.m - Non-specified Industry
 - 1.A.3 - Transport
 - 1.A.3.a - Civil Aviation
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 - 1.A.3.b.ii.1 - Light-duty trucks wi
 - 1.A.3.b.ii.2 - Light-duty trucks wi
 - 1.A.3.b.iii - Heavy-duty trucks and b

Fuel Consumption Data Fuel Combustion Emissions

Worksheet

Sector: Energy

Category: Fuel Combustion Activities

Subcategory: 1.A.3.e.i - Pipeline Transport

Sheet: Fuel Combustion Emissions

Data

Fuel Type: Liquid Fuels

Uncertainties for Liquid Fuels

Equation 2.4

Fuel consumption			CO2			CH4		N2O	
Subdivision	Fuel	Total fuel consumption (TJ)	CO2 Emission Factor (kg CO2/TJ)	Amount Captured (Gg CO2)	CO2 Emissions (Gg CO2)	CH4 Emission Factor (kg CH4/TJ)	CH4 Emissions (Gg CH4)	N2O Emission Factor (kg N2O/TJ)	N2O Emissions (Gg N2O)
S	F	C	EF(CO2)	Z	CO2=C*EF (CO2)/10^6-Z	EF(CH4)	CH4=C*EF (CH4)/10^6	EF(N2O)	N2O=C*EF (N2O)/10^6
Unspecified	Gas/Diesel Oil	30100	74100		2230.41	3	0.0903	0.6	0.01806
Total		30100			2230.41		0.0903		0.01806

User-defined parameter



Let's do an example with the
inventory tool!

Exercise 5: Other transportation

Activity 01

Step 01: Open the worksheet fuel consumption data of 1.A.3.e.i – Pipeline transport

Step 02: Select the fuel type as liquid fuels

Step 03: Enter following data accordingly

Input parameter	Entry	Note
Subdivision	Unspecified	
Fuel	Gas/ diesel oil	
Consumption	70 Gg (Auto CF)	

**the activity data used in this activity is not real. Just an example only for this activity.*

Step 04: Save entered data

Step 05: Open the worksheet Fuel combustion emissions

Step 06: Select the fuel type as liquid fuels

Step 07: Open the dialog box uncertainties for liquid fuels and enter following data accordingly

Entry parameter		Entry
Activity data uncertainties	Upper	+5.00%
	Lower	-5.00%
Emission factors uncertainties		
Select the gas as Carbon dioxide and enter following data <i>(*when you are entering data for real GHG inventory calculation, please make sure to enter uncertainties for other gases also)</i>		
	Upper	+5.00%
	Lower	-5.00%

**these values are not real. Just an example only for this activity.*

Step 08: Enter following data accordingly in the opened worksheet

Input parameter	Entry	Note
CO ₂ emission factor	Default value, 74100	You can use specific values also. But please use the default value for this activity.
Amount captured	0 (Zero)	
CH ₄ emission factor	Default value, 3	You can use specific values also. But please use the default value for this activity.
N ₂ O emission factor	Default value, 0.6	You can use specific values also. But please use the default value for this activity.

**the activity data used in this activity is not real. Just an example only for this activity.*

Step 09: Save entered data

Results



Fuel consumption data

Fuel Consumption Data Fuel Combustion Emissions

Worksheet

Sector: Energy 2020

Category: Fuel Combustion Activities

Subcategory: 1.A.3.e.i - Pipeline Transport

Sheet: Fuel Consumption Data

Data

Fuel Type Liquid Fuels

Equation 2.4

Subdivision	Fuel	Consumption (Mass, Volume or Energy Unit)	Consumption Unit	Conversion Factor (TJ/Unit) (NCV)	Total consumption (TJ)	
S	F	C	U	CF	TC = C * CF	
► Unspecified	Gas/Diesel Oil	70	Gg (Auto CF)	43	3010	
* Total					3010	



Uncertainties for liquid fuels

Uncertainties by Fuel Type



Liquid Fuels

Category

Sheet

Activity Data Uncertainties

Lower

Upper

Emission Factors Uncertainties

Gas

Lower

Upper

OK

Cancel



Fuel combustion emissions

Fuel Consumption Data | Fuel Combustion Emissions

Worksheet

Sector: Energy 2020

Category: Fuel Combustion Activities

Subcategory: 1.A.3.e.i - Pipeline Transport

Sheet: Fuel Combustion Emissions

Data

Fuel Type: Liquid Fuels Uncertainties for Liquid Fuels

Equation 2.4

Fuel consumption			CO2			CH4		N2O	
Subdivision	Fuel	Total fuel consumption (TJ)	CO2 Emission Factor (kg CO2/TJ)	Amount Captured (Gg CO2)	CO2 Emissions (Gg CO2)	CH4 Emission Factor (kg CH4/TJ)	CH4 Emissions (Gg CH4)	N2O Emission Factor (kg N2O/TJ)	N2O Emissions (Gg N2O)
S	F	C	EF(CO2)	Z	$CO_2 = C * EF(CO_2) / 10^6 - Z$	EF(CH4)	$CH_4 = C * EF(CH_4) / 10^6$	EF(N2O)	$N_2O = C * EF(N_2O) / 10^6$
► Unspecified	Gas/Diesel Oil	3010	74100		223.041	3	0.00903	0.6	0.00181
Total		3010			223.041		0.00903		0.00181

1.A.3.e.ii - Off-road

1. Fuel consumption data

Select the 'fuel type'

Fuel Type (All fuels) dropdown menu showing options: (All fuels), Liquid Fuels, Solid Fuels, Gaseous Fuels, Other Fossil Fuels, Biomass - solid, Biomass - liquid, Biomass - gas, Biomass - other.

Fuel Name	Net Calorific Value (TJ / Gg)	Carbon content (NCV) (kg C / GJ)
Aviation Gasoline	44.3	19.1
Bitumen	40.2	22
Crude Oil	42.3	20
Ethane	46.4	16.8
Gas/Diesel Oil	43	20.2
Jet Gasoline	44.3	19.1
Jet Kerosene	44.1	19.5
Liquefied Petroleum Gases	47.3	17.2

Select the 'fuel'

Gg (Auto CF)
Gg (Manual CF)
TJ

Click 'save' button finally to save the information you entered

User-defined parameter

Default parameter

2020

Fuel Consumption Data

Sector: Energy
Category: Fuel Combustion Activities
Subcategory: 1.A.3.e.ii - Off-road
Sheet: Fuel Consumption Data

Data

Fuel Type: Liquid Fuels

Equation 3.3.1, 3.3.2

Subdivision	Source	Fuel	Vehicle / Equipment	Consumption (Mass, Volume or Energy Unit)	Consumption Unit	Conversion Factor (TJ/Unit) (NCV)	Total consumption (TJ)
S	SRC	F		C	U	CF	TC = C * CF
Unspecified	Off-road - Commerci...	Gas/Diesel Oil	Tractor	5000	Gg (Auto CF)	43	215000
Total							215000

The user must enter these information accordingly

- 1.A.2.j - Wood and wood products
- 1.A.2.k - Construction
- 1.A.2.l - Textile and Leather
- 1.A.2.m - Non-specified Industry
- 1.A.3 - Transport
 - 1.A.3.a - Civil Aviation
 - 1.A.3.a.i - International Aviation (Int)
 - 1.A.3.a.ii - Domestic Aviation
 - 1.A.3.b - Road Transportation
 - 1.A.3.b.i - Cars
 - 1.A.3.b.i.1 - Passenger cars wit
 - 1.A.3.b.i.2 - Passenger cars wit
 - 1.A.3.b.ii - Light-duty trucks
 - 1.A.3.b.ii.1 - Light-duty trucks wi
 - 1.A.3.b.ii.2 - Light-duty trucks wi
 - 1.A.3.b.iii - Heavy-duty trucks and b
 - 1.A.3.b.iv - Motorcycles

2. Fuel combustion emissions

Select the 'fuel type'

Fuel Type (All fuels) dropdown menu showing options: (All fuels), Liquid Fuels, Solid Fuels, Gaseous Fuels, Other Fossil Fuels, Biomass - solid, Biomass - liquid, Biomass - gas, Biomass - other.

Uncertainties by Fuel Type dialog box for Liquid Fuels. Category: 1.A.3.e.ii - Off-road. Sheet: Fuel Combustion Emissions. Activity Data Uncertainties: Lower -5.00%, Upper +5.00%. Emission Factors Uncertainties: Gas CARBON DIOXIDE (CO2), Lower -2.41%, Upper +3.87%. Buttons: OK, Cancel.

Enter uncertainties for activity data and emission factors of each gas (CH₄, CO₂, N₂O)

Click 'save' button finally to save the information you entered

User-defined or default parameters

- 1.A.2.i - Mining (excluding fuels) and Q
- 1.A.2.j - Wood and wood products
- 1.A.2.k - Construction
- 1.A.2.l - Textile and Leather
- 1.A.2.m - Non-specified Industry
- 1.A.3 - Transport
 - 1.A.3.a - Civil Aviation
 - 1.A.3.a.i - International Aviation (Int)
 - 1.A.3.a.ii - Domestic Aviation
 - 1.A.3.b - Road Transportation
 - 1.A.3.b.i - Cars
 - 1.A.3.b.i.1 - Passenger cars wit
 - 1.A.3.b.i.2 - Passenger cars wit
 - 1.A.3.b.ii - Light-duty trucks
 - 1.A.3.b.ii.1 - Light-duty trucks wi
 - 1.A.3.b.ii.2 - Light-duty trucks wi
 - 1.A.3.b.iii - Heavy-duty trucks and b
 - 1.A.3.b.iv - Motorcycles
 - 1.A.3.b.v - Evaporative emissions fr

Fuel Consumption Data | Fuel Combustion Emissions | Fuel Combustion Emissions - Tier 3

Worksheet: Energy, Fuel Combustion Activities, 1.A.3.e.ii - Off-road, Fuel Combustion Emissions

Data: Fuel Type Liquid Fuels, Uncertainties for Liquid Fuels

Equation 3.3.1, 3.3.2					CO ₂		CH ₄		N ₂ O		
Fuel consumption					CO ₂ Emission Factor (kg CO ₂ /TJ)	Amount Captured (Gg CO ₂)	CO ₂ Emissions (Gg CO ₂)	CH ₄ Emission Factor (kg CH ₄ /TJ)	CH ₄ Emissions (Gg CH ₄)	N ₂ O Emission Factor (kg N ₂ O/TJ)	N ₂ O Emissions (Gg N ₂ O)
Subdivision	Source	Fuel	Vehicle / Equipment	Total fuel consumption (TJ)	EF(CO ₂)	Z	CO ₂ =C*E F (CO ₂)/10 ⁶ -Z	EF(CH ₄)	CH ₄ =C*E F (CH ₄)/10 ⁶	EF(N ₂ O)	N ₂ O=C*E F (N ₂ O)/10 ⁶
Unspecified	Off-road - C...	Gas/Diesel Oil	Tractor	215000	74100	0	15931.5	4.15	0.89225	28.6	6.149
Total				215000			15931.5		0.89225		6.149

The user must enter these information accordingly

User-defined parameter



Let's do an example with the
inventory tool!

1.A.4.c.ii – Off-road vehicles and other machinery

- Worksheets have same format as in sub-category 1.a.3.ii.e – Off-road
 - There are 3 worksheets
 1. Fuel consumption data
 2. Fuel combustion emissions

□ Tier 01

Tier 1		
Emission = $\sum_j [\text{Fuel}_j * \text{Emission Factor}_j]$		
Parameter	Description	Unit
Emission	Emissions	kg
Fuel _j	Fuel consumed	TJ
EF _j	Emission factor	Kg/TJ
j	Fuel type	N/A

❖ Tier 1 approach use fuel-specific default emission factors

Default EF can be
obtained from 2006 IPCC
guideline >> Volume 2
>> Chapter 3

Calculation example to find emissions from off-road vehicles and other machinery in Philippines 2010, tier 1

2006, IPCC default EF



TABLE 3.3.1
DEFAULT EMISSION FACTORS FOR OFF-ROAD MOBILE SOURCE MACHINERY^(a)

Off-Road Source	CO ₂			CH ₄ ^(b)			N ₂ O ^(c)		
	Default (kg/TJ)	Lower	Upper	Default (kg/TJ)	Lower	Upper	Default (kg/TJ)	Lower	Upper
Diesel									
Agriculture	74 100	72 600	74 800	4.15	1.67	10.4	28.6	14.3	85.8
Forestry	74 100	72 600	74 800	4.15	1.67	10.4	28.6	14.3	85.8
Industry	74 100	72 600	74 800	4.15	1.67	10.4	28.6	14.3	85.8
Household	74 100	72 600	74 800	4.15	1.67	10.4	28.6	14.3	85.8
Motor Gasoline 4-stroke									
Agriculture	69 300	67 500	73 000	80	32	200	2	1	6
Forestry	69 300	67 500	73 000						
Industry	69 300	67 500	73 000	50	20	125	2	1	6
Household	69 300	67 500	73 000	120	48	300	2	1	6
Motor Gasoline 2-Stroke									
Agriculture	69 300	67 500	73 000	140	56	350	0.4	0.2	1.2
Forestry	69 300	67 500	73 000	170	68	425	0.4	0.2	1.2
Industry	69 300	67 500	73 000	130	52	325	0.4	0.2	1.2
Household	69 300	67 500	73 000	180	72	450	0.4	0.2	1.2

The EF not available in **YELLOW** color cells are not in IPCC default EFs. Therefore, those values can be taken from **Literatures, National institutes** or can develop those EF with expert consultations etc.

Off-road source	Fuel type	Consumption (ktoe)	2006 IPCC default emission factor (kg/TJ)			Conversion factor (TJ/ ktoe)
			CO ₂	CH ₄	N ₂ O	
Agri crop products	Regular gasoline	0.21	69300	80	2	41.87
	Kerosene	0.25				41.87
	Diesel	11.91	74100	4.15	28.6	41.87
Livestock/ poultry	Regular gasoline	0.02	69300	80	2	41.87
	Diesel	1.15	74100	4.5	28.6	41.87
	Fuel oil	4.24				41.87
Agri services	Regular gasoline	0.01	69300	80	2	41.87
	Kerosene	0.16				41.87
	Diesel	3.75	74100	4.15	28.6	41.87
	Fuel oil	1.30				41.87

*a conversion factor is used in here because activity data was given in ktoe (kilo tonne of oil equivalents)

Off-road source	Fuel type	Emissions = Fuel consumption * EF		
		CO ₂	CH ₄	N ₂ O
Agri crop products	Regular gasoline	<p>Fuel consumption = 0.21 ktoe *</p> <p>41.87 TJ/ ktoe = 8.7927 TJ</p> <p>$E_{CO_2} = 8.7927 \text{ TJ} * 69300 \text{ kg/TJ} = 609334.11 \text{ kg}$ or 0.61 Gg</p>	<p>$E_{CH_4} = 8.7927 \text{ TJ} * 80 \text{ kg/TJ} = 703.416 \text{ kg}$ or $0.71 * 10^{-3} \text{ Gg}$</p>	<p>$E_{N_2O} = 8.7927 \text{ TJ} * 2 \text{ kg/TJ} = 17.5854 \text{ kg}$ or $0.018 * 10^{-3} \text{ Gg}$</p>

Calculations for other off-road sources also do same as this way. Only the EF will change accordingly

If CO₂ captured, the captured amount must subtract from the total CO₂ emissions to get net CO₂ emissions

1.A.4.c.iii – Fishing (mobile combustion)

- Worksheets have same formats as in sub-categories *1.A.3.d.i – International water-borne navigation (International bunkers)* and *1.A.3.d.ii – Domestic water-borne navigation*
 - There are 2 worksheets in each sub-category
 1. Fuel consumption data
 2. Fuel combustion emissions

- Two methodological tiers for estimating emissions of CO₂, CH₄, and N₂O

Tier 1	<ul style="list-style-type: none"> Apply either default values or country-specific information
--------	---

Water-borne navigation equation		
Emission = \sum [Fuel Consumed _{ab} * Emission Factor _{ab}]		
Parameter	Description	Unit
Emission	Emissions of CO ₂ , CH ₄ , N ₂ O	kg
a	Fuel type e (diesel, gasoline, LPG, bunker, etc.)	N/A
b	Water-borne navigation type (i.e., Ship or boat, and possibly engine type.) (Only at tier 2 is the fuel used differentiated by type of vessel so, b can be ignored at tier 1)	N/A

Default EF can be obtained from
 2006 IPCC guideline >>
 Volume 2 >>
 Chapter 3

Calculation example to find emissions from water-borne navigation in Philippines 2010, tier 1

2006, IPCC default EF

Fuel type	Consumption (ktoe)	2006 IPCC default emission factor (kg/TJ)			Conversion factor (TJ/ ktoe)
		CO ₂	CH ₄	N ₂ O	
Regular Gasoline	1.49	69300	7	2	41.87
Kerosene	1.26	71900	7	2	41.87
Diesel	241.14	74100	7	2	41.87
Fuel oil	15.55	77400	7	2	41.87

TABLE 3.5.2
CO₂ EMISSION FACTORS

Fuel	kg/TJ			
	Default	Lower	Upper	
Gasoline	69 300	67 500	73 000	
Other Kerosene	71 900	70 800	73 600	
Gas/Diesel Oil	74 100	72 600	74 800	
Residual Fuel Oil	77 400	75 500	78 800	
Liquefied Petroleum Gases	63 100	61 600	65 600	
Other Oil	Refinery Gas	57 600	48 200	69 000
	Paraffin Waxes	73 300	72 200	74 400
	White Spirit & SBP	73 300	72 200	74 400
	Other Petroleum Products	73 300	72 200	74 400
Natural Gas	56 100	54 300	58 300	

*a conversion factor is used in here because activity data was given in ktoe (kilo tonne of oil equivalents)

Fuel type	Emissions = Fuel consumption * EF		
	CO ₂	CH ₄	N ₂ O
Regular Gasoline	<p>Fuel consumption = 1.49 ktoe * 41.87 TJ/ ktoe = 62.3863 TJ</p> <p>$E_{CO_2} = 62.3863 \text{ TJ} * 69300 \text{ kg/TJ} = 4323370 \text{ kg}$ or 4.33 Gg</p>	<p>436.7041kg or $0.44 * 10^{-3} \text{ Gg}$</p>	<p>124.7726 kg or $0.13 * 10^{-3} \text{ Gg}$</p>

TABLE 3.5.3
DEFAULT WATER-BORNE NAVIGATION CH₄ AND N₂O EMISSION FACTORS

	CH ₄ (kg/TJ)	N ₂ O (kg/TJ)
Ocean-going Ships *	7 ± 50%	2 +140% -40%

*Default values derived for diesel engines using heavy fuel oil.
Source: Lloyd's Register (1995) and EC (2002)

1.A.5.b.i – Mobile (aviation component)

- Worksheets have same formats as in sub-categories *1.A.3.a.i – International aviation* and *1.A.3.a.ii – Domestic aviation*
 - Four worksheets in each sub-category
 1. Fuel consumption data
 2. Fuel combustion emissions} Tier 1

1.A.5.b.ii – Mobile (water-borne component)

- Worksheets have same formats as in sub-categories *1.A.3.d.i – International water-borne navigation (International bunkers)* and *1.A.3.d.ii – Domestic water-borne navigation*
 - There are 2 worksheets in each sub-category
 1. Fuel consumption data
 2. Fuel combustion emissions

1.A.5.b.iii – Mobile (Other)

- There are 5 worksheets in this sub-category
 1. Road: Fuel consumption data
 2. Road: Fuel combustion emissions
 3. Off-road: Fuel consumption data
 4. Off-road: Fuel combustion emissions
- These worksheets have same formats similar to worksheets in forementioned sub-categories



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