

Exercise 1

Emission Quantification

Time: 25 minutes

1. Top-down approach

In 2010, city A consumed 500.0 million Liter of gasoline, 200.0 million Liter of diesel and 100 tons of Compressed Natural Gas (CNG), and 90% of gasoline, 40% of diesel and 80% of CNG was consumed by transport sector.

Task 1: Please calculate the total tank-to-wheel greenhouse gas emissions emitted from the transport sector.

Fuel Type	Conversion Factor					
	tank-to-wheel			well-to-wheel		
	gCO2/MJ	kgCO2/kg	kgCO2/l	gCO2/MJ	kgCO2/kg	kgCO2/l
Gasoline	73.4	3.17	2.36	87.5	3.78	2.82
Ethanol	0	0	0	28.0	0.75	0.60
Diesel	73.3	3.16	2.63	89.1	3.84	3.19
Biodiesel	0	0	0	16.9	0.62	0.55
Liquefied Petroleum Gas (LPG)	65.7	3.02	1.66	73.2	3.37	1.85
Compressed Natural Gas (CNG)	56.2	2.54	x	61.7	2.78	x

2. Bottom-up approach

City A has 500,000 light duty passenger cars, in which 100,000 vehicles are small-sized cars (engine capacity $\leq 1.0\text{L}$), 300,000 vehicles are medium-sized cars (engine capacity $1.0 - 2.0\text{L}$), and 100,000 vehicles are large-sized cars (engine capacity $> 2.0\text{L}$). All cars are fueled by gasoline. Annual average kilometers travelled and average carbon emission factors for each of the three vehicle categories are shown in the below table.

Task 2: Please calculate the annual greenhouse gas emissions caused by the gasoline-fueled passenger cars.

Vehicle category	Annual average kilometres travelled	Average emission factor (CO ₂ g/km): tank-to-wheel
small size car	11,000	120
medium size car	13,000	160
large size car	15,000	200

Group Task

Compare the tank-to-wheel emissions calculated by using the bottom-up approach with the results based on the top-down approach (only gasoline).

What are reasons for differences between both results?

Solution

Top-down: CO2 Emissions

- **Emissions from Gasoline**
 - 500.0 million Liter X 90% X 2.36 kg/L / 1000 = **1,062,000 ton**
 - **Emissions from Diesel**
 - 200.0 million Liter X 40% X 2.63 kg/L / 1000 = **210,400 ton**
 - **Emissions from CNG**
 - 100 tons X 80% X 2.54 kg/kg / 1000 = **203 ton**
-
- **Total** **1,272,403 ton**

Bottom up: CO2 Emissions

- **Small cars**
 - 100,000 cars X 11,000km *120 g/km = **132,000 ton**
 - **Medium cars**
 - 300,000 cars X 13,000km *160 g/km = **624,000 ton**
 - **Large cars**
 - 100,000 cars X 15,000km *200 g/km = **300,000 ton**
-
- **Total** **1,056,000 ton**

Approach to Measure Mobile Source Emissions

