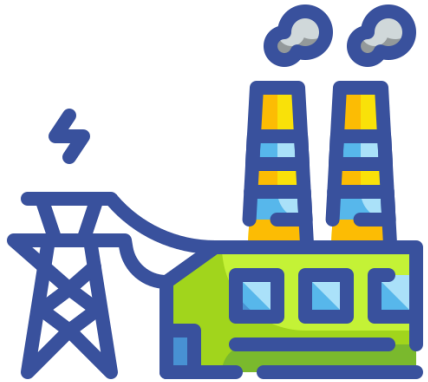
Reference and Sectoral Approach Calculation



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Overview

Sectoral Approach vs. Reference Approach

- Apply both approaches for a comprehensive assessment.
- Sectoral: Breakdown emissions by specific sectors (e.g., transportation, industry).
- Reference: Utilize national-level data for a holistic overview.

Independent Estimates for Validation

- Conduct independent estimations using both approaches.
- Facilitates cross-verification and enhances reliability.

Identifying Discrepancies

- Analyze variations between sectoral and reference estimates.
- Significant differences may indicate potential issues.

Potential Problem Areas

- Activity Data: Scrutinize data related to activities generating emissions.
- Net Calorific Values: Ensure accurate values for energy content calculations.
- Carbon Content: Verify the carbon content of different fuel types.
- Excluded Carbon Calculation: Review factors contributing to excluded carbon.

Enhancing Accuracy and Transparency

- Regularly update activity data to reflect changes in emissions sources.
- Improve precision in net calorific values and carbon content determinations.
- Enhance transparency in excluded carbon calculation methodologies.

Benefits of Dual Approach

- Comprehensive insights into emissions sources.
- Improved accuracy through cross-verification.
- Enhanced policymaking and mitigation strategies.

Reference Approach

Source categories covered

The Reference Approach is designed to calculate the emissions of CO2 from fuel combustion, starting from high level energy supply data.

The assumption is that carbon is conserved so that, for example, carbon in crude oil is equal to the total carbon content of all the derived products.

The Reference Approach does not distinguish between different source categories within the energy sector and only estimates total CO2 emissions from Source category 1A, Fuel Combustion.

Emissions derive both from combustion in the energy sector, where the fuel is used as a heat source in refining or producing power, and from combustion in final consumption of the fuel or its secondary products.

Reference Approach

What is the Reference Approach ?

- Top-down approach to estimating emissions.
- Relies on country-level energy supply data and aggregated statistics.
- Doesn't delve into the specifics of individual fuel consumption within sectors.

Reference Approach

Data Utilization :

Uses national energy supply statistics to estimate total CO2 emissions.

Does not consider the intricate variations in how different fuels are utilized within specific sectors.

Provides a broad, high-level view of emissions based on overall energy supply.

Reference Approach

Limitations:

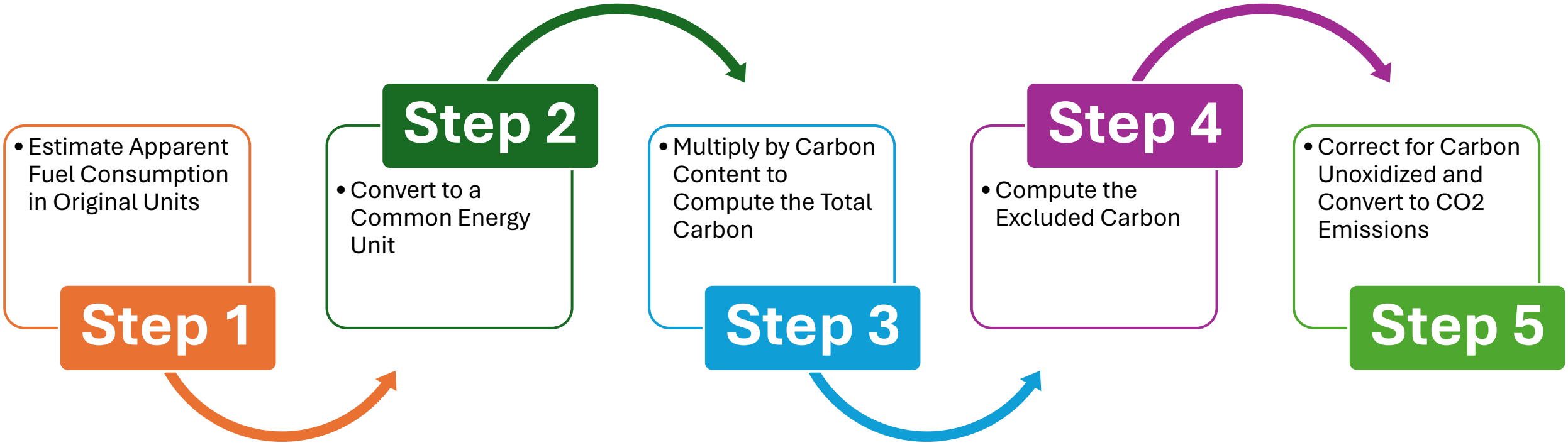
Lacks granularity, leading to a lack of insight into specific sectoral emissions.

Doesn't consider factors like carbon capture or fugitive emissions.

Reference Approach

Algorithm

The Reference Approach methodology breaks the calculation of carbon dioxide emissions from fuel combustion into 5 steps;



Reference Approach

Algorithm Cont.

Above steps are expressed in the following equation;

EQUATION 6.1

CO_2 EMISSIONS FROM FUEL COMBUSTION USING THE REFERENCE APPROACH

$$CO_2\ Emissions = \sum_{all\ fuels} \left[\left(\left(Apparent\ Consumption_{fuel} \bullet Conv\ Factor_{fuel} \bullet CC_{fuel} \right) \bullet 10^{-3} - Excluded\ Carbon_{fuel} \right) \bullet COF_{fuel} \bullet 44/12 \right]$$

Where:

CO_2 Emissions	= CO_2 emissions (Gg CO_2)
Apparent Consumption	= production + imports – exports – international bunkers - stock change
Conv Factor (conversion factor)	= conversion factor for the fuel to energy units (TJ) on a net calorific value basis
CC	= carbon content (tonne C/TJ) Note that tonne C/TJ is identical to kg C/GJ
Excluded Carbon	=carbon in feedstocks and non-energy use excluded from fuel combustion emissions (Gg C)
COF (carbon oxidation factor)	= fraction of carbon oxidised. Usually the value is 1, reflecting complete oxidation. Lower values are used only to account for carbon retained indefinitely in ash or soot
44/12	= molecular weight ratio of CO_2 to C.

Reference Approach

Required activity data

Step 1

Apparent consumption

The following data are required for each fuel and inventory year;

- The amounts of primary fuels produced1 (production of secondary fuels and fuel products is not included)
- The amounts of primary and secondary fuels imported
- The amounts of primary and secondary fuels exported
- The amounts of primary and secondary fuels used in international bunkers
- The net increases or decreases in stocks of primary and secondary fuels

The apparent consumption of a primary fuel is, therefore, calculated from the data as

EQUATION 6.2
APPARENT CONSUMPTION OF PRIMARY FUEL

$$Apparent\ Consumption_{fuel} = Production_{fuel} + Imports_{fuel} - Exports_{fuel} - International\ Bunkers_{fuel} - Stock\ Change_{fuel}$$

Reference Approach

Conversion to energy units

Step 2

Often oil and coal data are expressed in metric tonnes. Natural gas may be expressed in cubic meters or in a heat value such as BTU on a gross or net calorific value basis.

For the purposes of the Reference Approach, the apparent consumption should be converted to terajoules on a net calorific value basis

When selecting a country-specific calorific value for the Reference Approach based on detailed consumption values, good practice suggests that a weighted average be used.

Reference Approach

Carbon content

Step 3

The carbon content of the fuel may vary considerably both among and within primary fuel types;

For natural gas, the carbon content depends on the composition of the gas which, in its delivered state, is primarily methane, but can include small quantities of ethane, propane, butane, CO2 and heavier hydrocarbons.

For crude oil, the carbon content may vary depending on the crude oil's composition.

For secondary oil products, the carbon content for light refined products such as gasoline is usually less than for heavier products such as residual fuel oil.

For coal, the carbon content per tonne varies considerably depending on the coal's composition of carbon, hydrogen, sulphur, ash, oxygen, and nitrogen.

For a given fuel, the country-specific carbon content may vary over time. In this instance, different values may be used in different years.

Reference Approach

Excluded carbon

Step 4

This step is to exclude from the total carbon the amount of carbon which does not lead to fuel combustion emissions, because the aim is to provide an estimate of fuel combustion emissions (Source category 1A).

The main flows of carbon concerned in the calculation of excluded carbon are those used as;

- Feedstock
- Reductant
- Non-energy products.

Example:

Feedstock

Naphtha

LPG (butane/propane)

Refinery gas

Gas/diesel oil and Kerosene

Natural gas

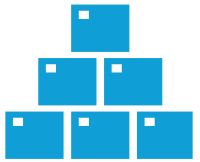
Ethane

Reductant

Coke oven coke (metallurgical coke) and petroleum coke

Coal and coal tar/pitch

Natural gas



Non-energy products

Bitumen

Lubricants

Paraffin waxes

White spirit

Reference Approach

Feedstock

Step 4

Introduction:	Exclusion Principle:	Heat Raising Considerations:	By-Products and Fuel Combustion:	Application of Principle:	Discrepancies and Explanations:
• Carbon emissions from fuels used as feedstock are reported within the Industrial Processes and Product Use (IPPU) chapter. • These emissions are excluded from the total carbon of apparent energy consumption.	• Fuels delivered as feedstock must be deducted from the total carbon of apparent energy consumption. • Careful consideration is needed to distinguish between feedstock use and fuel combustion.	• Many fuels used as feedstock are also employed for heat raising in refineries or other processes. • Ensure that only quantities of fuel delivered for feedstock use are subtracted from total carbon.	• Processing feedstock may yield by-product gases or oils. • Some feedstock supply might be used to fuel the process. • Emission reporting follows the principle outlined in Section 1.2 of the Introduction chapter.	• Countries may report some feedstock carbon as fuel combustion emissions in their inventories. • The Reference Approach maintains complete exclusion of feedstock carbon for simplicity.	• Acknowledge that differences between the Reference Approach and Sectoral Approach may arise. • It's good practice to quantify and explain any discrepancies during the reporting stage.

Reference Approach

Reductant

Coke oven coke and petroleum coke

Cokes from coals and oil products are vital in iron, steel, and non-ferrous metals industries for fuel combustion or industrial processes.

As a reductant in industrial processes, coke reacts with inorganic oxides, producing 'off gases' containing carbon monoxide and dioxide.

Off gases may be combusted on-site or elsewhere, with emissions reported as fuel combustion.

Due to data availability challenges, quantities of coke for these industries are excluded from total carbon in the Reference Approach to maintain simplicity.

Coal and coal tar/pitch

Pulverized coal as reductant in blast furnaces and titanium dioxide manufacturing.

Carbon from coal enters by-product gases in iron and steel industry (IPPU).

Emissions from blast furnace gas transfer as fuel fall under the Energy sector.

Coal distillation in coke ovens produces valuable tars, light oils (benzene, toluene, xylene), and by-products.

Emissions assumed covered under IPPU.

Pitches, used in anode production, and associated heavier oils excluded from fuel combustion emissions (IPPU).

Consider oil or tar burning in coke plants for reconciliation between Reference and Sectoral Approaches.

Natural gas

Natural gas injection in iron and steel plants as a reductant in the iron-making process.

Emission classification mirrors that of pulverized coal.

Exclude quantities related to gas injection from total carbon in the Reference Approach

Reference Approach

Non-energy products use

Bitumen/Asphalt:

Usage in road paving and roof covering.

Carbon remains stored for extended periods.

No fuel combustion emissions in the inventory year.

Lubricants:

Lubricating oil statistics cover various purposes, including engines, industrial uses, and heat transfer.

Exclude all deliveries of lubricating oil from the Reference Approach to prevent double counting.

Addresses combustion of waste lubricants under "other fossil fuels," except for two-stroke engine lubricants (Refer to Section 6.8).

Paraffin (Petroleum) Waxes:

Exclude all quantities of paraffin waxes from the Reference Approach.

Main uses leading to fuel combustion are candle burning for heating and incineration in municipal waste plants with heat recovery.

Candle usage for lighting is considered decorative and not fuel combustion.

Emissions from wax combustion in waste plants are already included in the Reference Approach ("Other fossil fuels").

White Spirit:

White spirit results in solvent emissions, distinct from fuel combustion.

Exclude white spirit emissions from the Reference Approach.

Reference Approach

Excluded carbon

The quantity of carbon to be excluded from the estimation of fuel combustion emissions is calculated according to following equation

EQUATION 6.4
CARBON EXCLUDED FROM FUEL COMBUSTION EMISSIONS

$$Excluded\ Carbon_{fuel} = Activity\ \ Data_{fuel} \bullet CC_{fuel} \bullet 10^{-3}$$

Where:

Excluded Carbon	= carbon excluded from fuel combustion emissions (Gg C)
Activity Data	= activity data (TJ)
CC	= carbon content (tonne C/TJ)

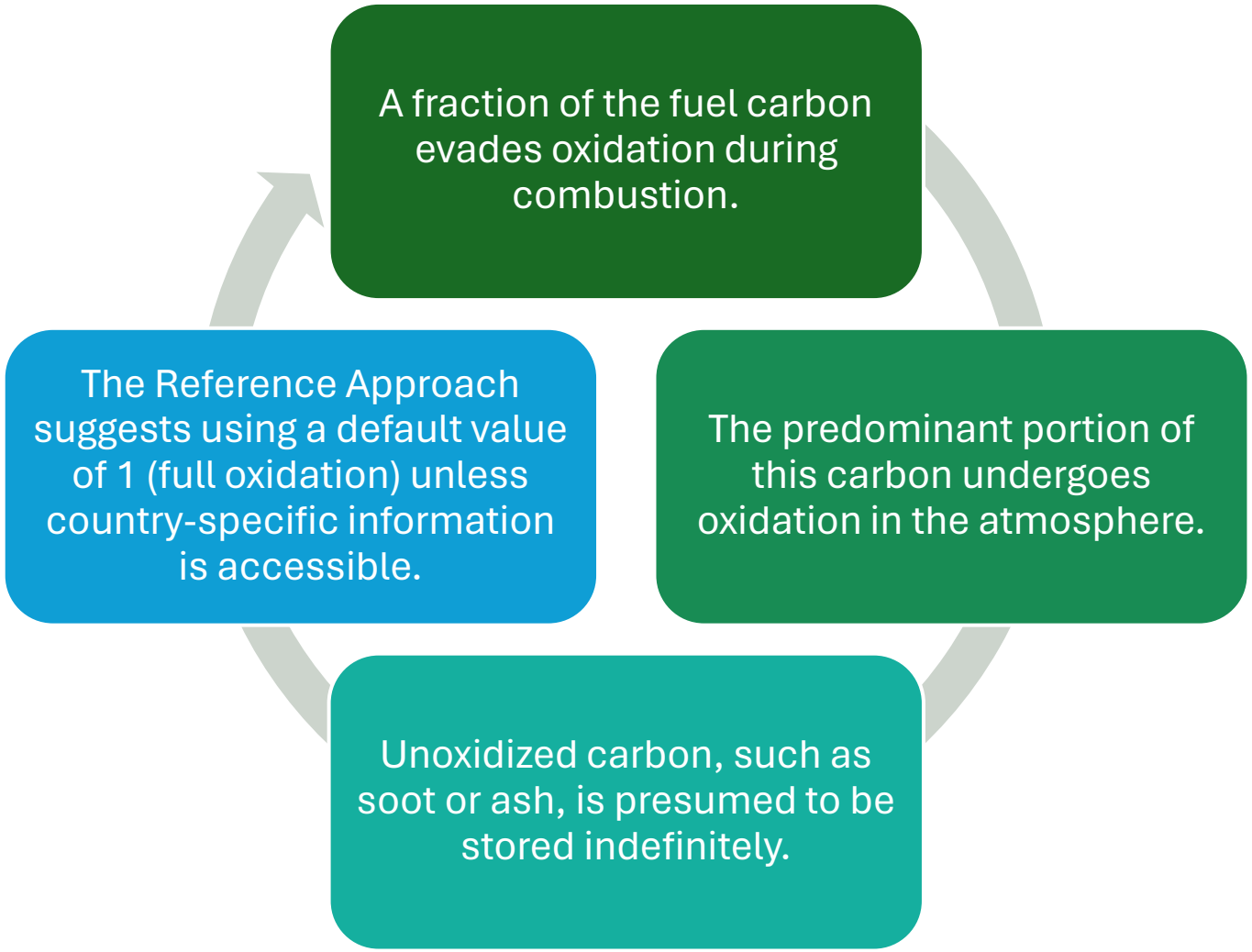
The activity data for each relevant product

Fuel	Activity data[1]
LPG, ethane, naphtha, refinery gas[2], gas/diesel oil, kerosene	Deliveries to petrochemical feedstocks[3]
Bitumen	Total deliveries
Lubricants	Total deliveries
Paraffin waxes[2]	Total deliveries
White spirit[2]	Total deliveries
Cokes	
Calcined petroleum coke	Total deliveries
Coke oven coke	Deliveries to the iron and steel and non-ferrous metals industries
Coal Tar	
Light oils from coal	Deliveries to chemical industry
Coal tar/pitch	Deliveries to chemical industry and construction
Natural gas	Deliveries to petrochemical feedstocks and for the direct reduction of iron ore in the iron and steel industry

Reference Approach

Carbon unoxidized during fuel combustion

Step 5

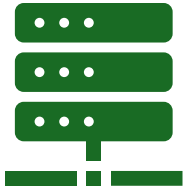


Sectoral Approach

Methodology

Bottom-up approach focusing on individual sectors and fuels.

Analyzes specific sectors to understand the consumption and emission patterns of various fuels.



Data Utilization

Considers detailed sector-specific data on fuel consumption and emissions.

Accounts for nuances in how fuels are utilized within each sector.

Allows for a more precise estimation of emissions compared to the Reference Approach

Advantages

Provides a more detailed and sector-specific breakdown of emissions.

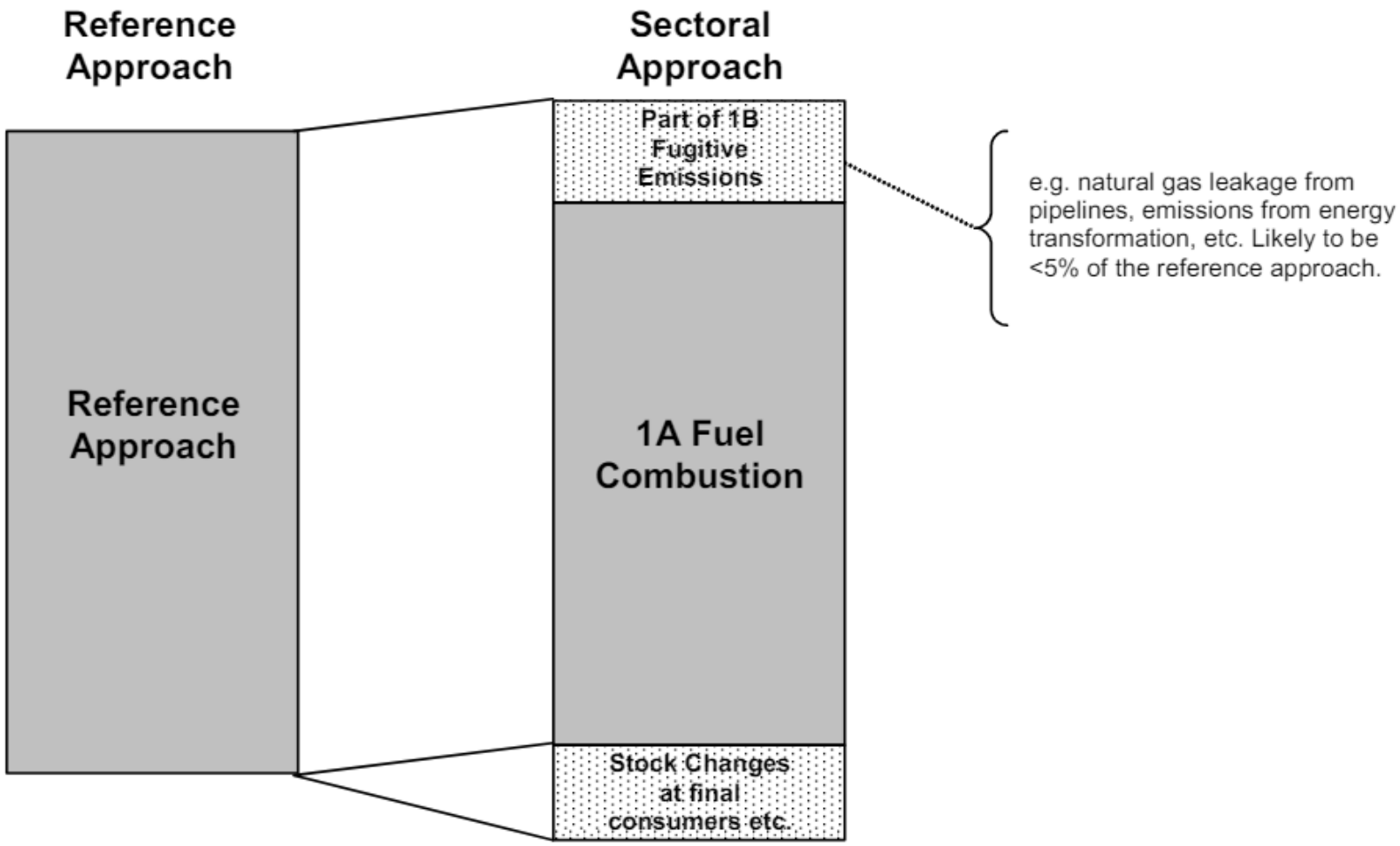
Allows for targeted interventions and policy formulation within sectors

Comparison

Reference Approach		Sectoral Approach
	Granularity	
Offers a broad, country-level perspective.		Provides a detailed, sector-specific view.
	Accuracy	
May overestimate or underestimate due to lack of sectoral detail.		Offers more accurate estimations due to detailed sector-specific analysis
	Applicability	
Useful for high-level comparisons across countries or regions.		Valuable for formulating targeted strategies within specific sectors.

Comparison Cont.

Reference approach versus sectoral approach



Exercise – Reference Approach.

Step 1

Activity data from OEB Sheet in Philippine – 2000 (Values are in ktoe)

Source : Page 154/155 , GHG Manual Rev3: https://climate.emb.gov.ph/wp-content/uploads/2016/06/GHG-Manual.pdf

	Coal	NatGas (Natural Gas)	Crud	Mortor Gasolin	Kero	Diesel	FuelOil	LPG	Jet (Jet Kerosine)	Other petroluim product	Naphtha	Asphalt (Bitumen)	Other Primary Biomass	CharCoa	FuelWooc	Bagasse (other bio gas)	animal waste (Sludge gas)
Production	644.7	9.0	56.0										7750.8	630.6	4362.0	585.0	12.0
Import	3596.2		15272.3	632.9	47.2	1000.3	415.9	696.3	154.8	4.6	57.2	6.8					
Export				150.0		86.7	910.3	6.3	5.3		635.4	1.4					
Bunkering						105.3	105.4										
Stock Change			33.1	29.4	-9.8	35.8	25.1	-2.2		0.5	-10.8	1.7					

Convert to TJ Values ↓ 1 ktoe = 41.87 TJ

Step 2

	Coal	NatGas (Natural Gas)	Crud	Mortor Gasolin	Kero	Diesel	FuelOil	LPG	Jet (Jet Kerosine)	Other petroluim product	Naphtha	Asphalt (Bitumen)	Other Primary Biomass	CharCoal	FuelWood	Bagasse (other bio gas)	animal waste (Sludge gas)
Production	26991.9	375.6	2343.5										324527.7	26403.2	182636.9	24494.0	502.4
Import	150572.9		639450.4	26497.4	1977.9	41881.7	17412.5	29153.7	6481.9	190.9	2395.0	286.4					
Export				6280.1		3629.7	38113.0	261.7	221.1		26602.5	56.5					
Bunkering						4408.5	4414.8										
Stock Change			1384.2	1230.6	-409.5	1500.2	1052.2	-92.5		20.9	-450.9	69.9					

Exercise – Reference Approach.

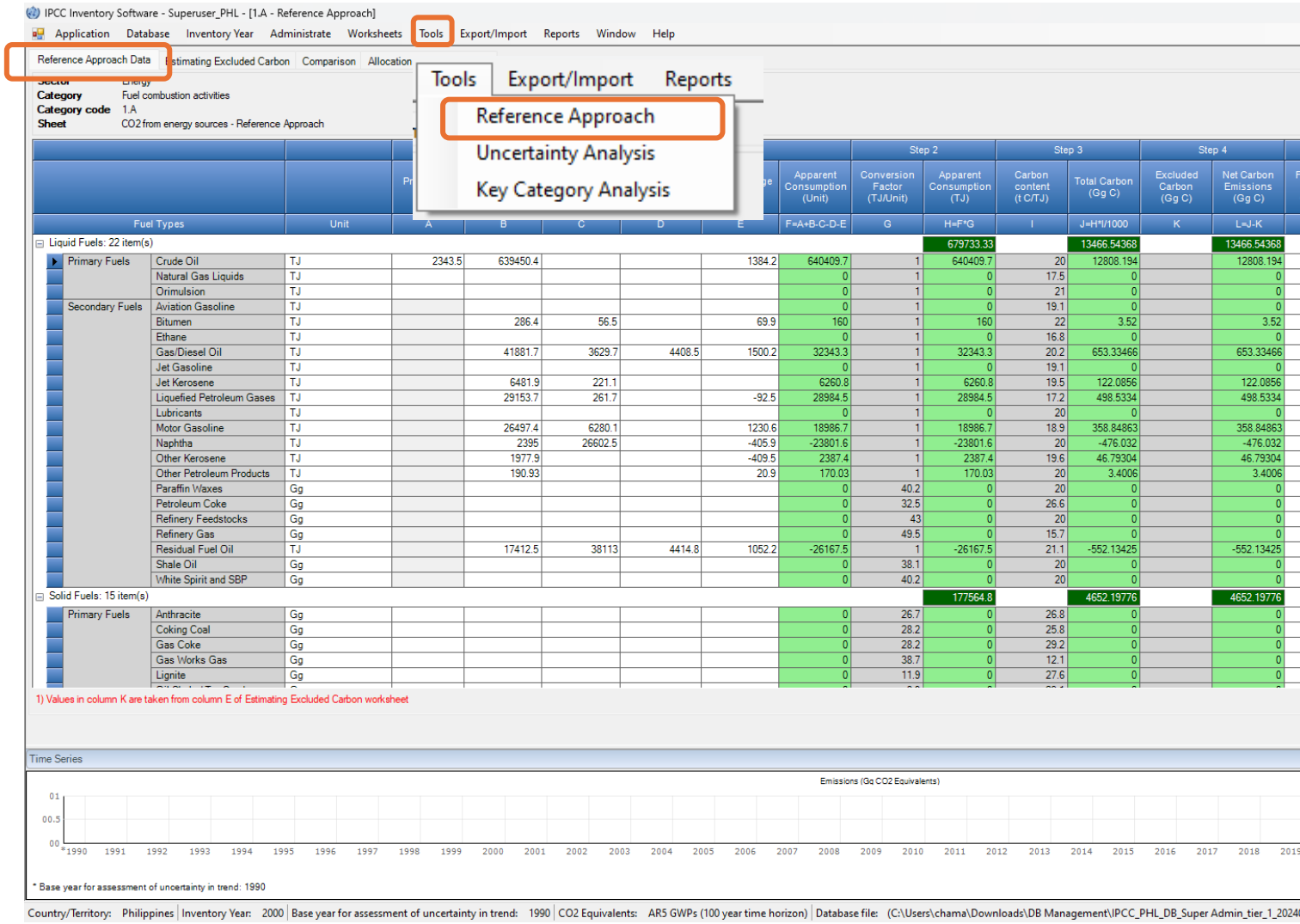
Begin by navigating to the "Tools" section.

Within the Tools menu, locate and choose the "Reference Approach" option.

Select the Reference Approach data sheet from the available options.

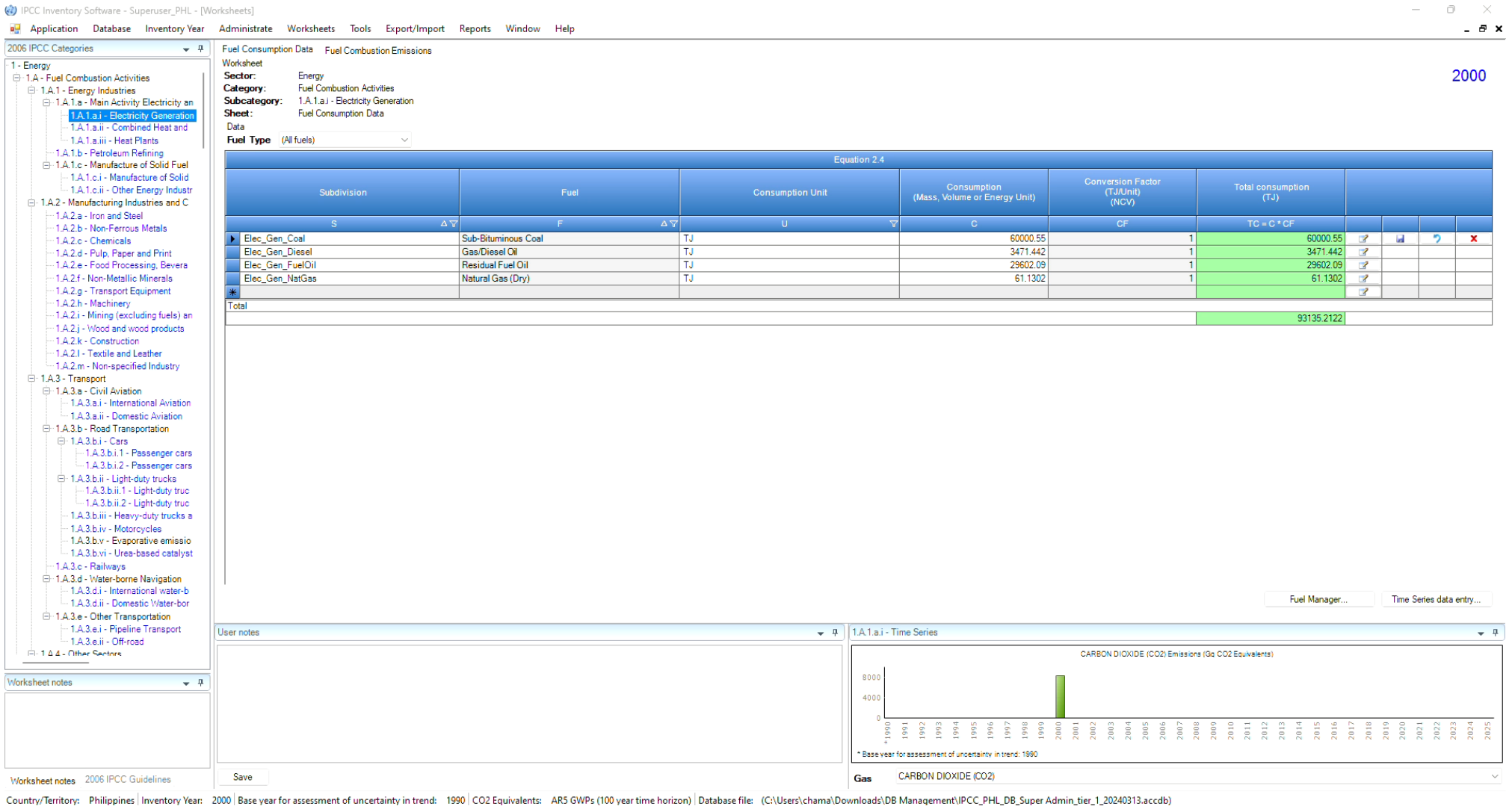
Proceed to fill out the activity data on the data sheet.

Ensure that the unit selected for these activities is set to TJ (terajoules).



Exercise – Reference Approach.

Completing the activity data on the datasheet.

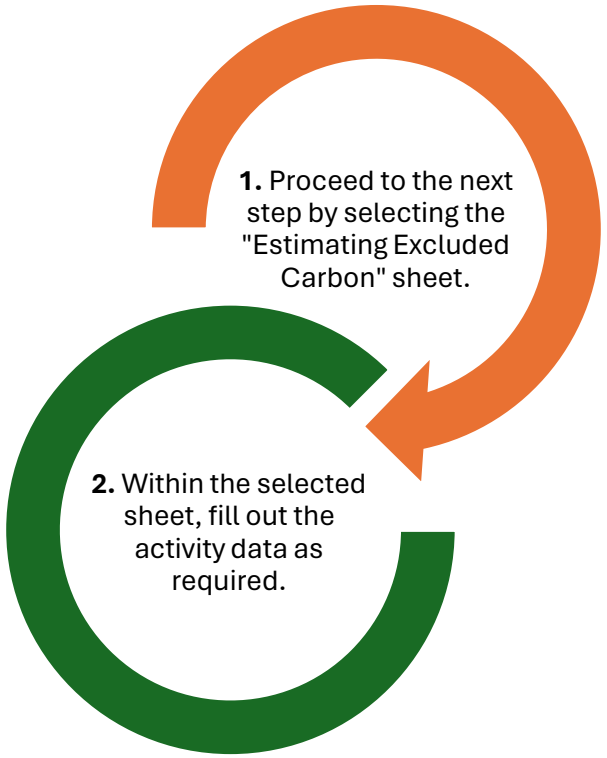


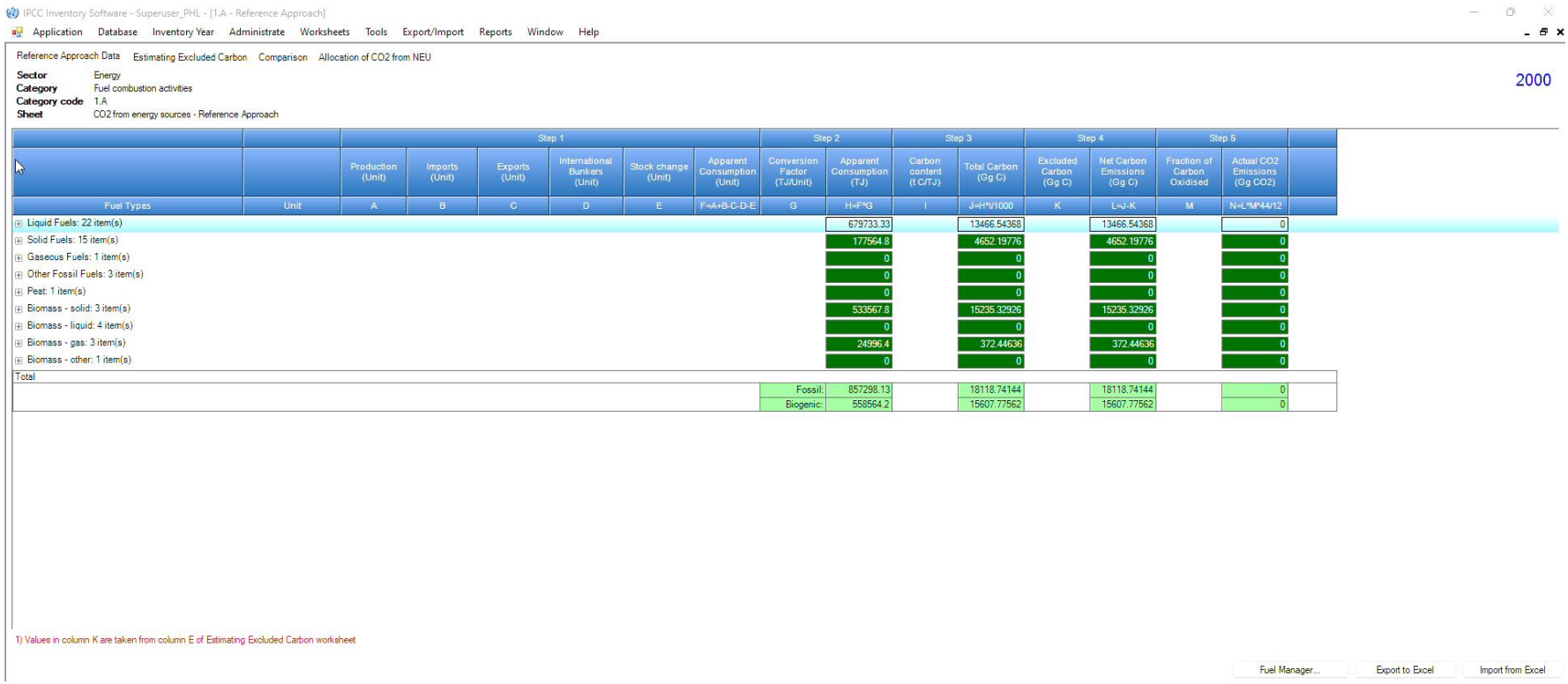
Exercise – Reference Approach.

Adding excluded carbon to the system.

As an example;

Fuel	Consumption (TJ)
Bitumen	160
Liquefied Petroleum Gases	2898.45





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