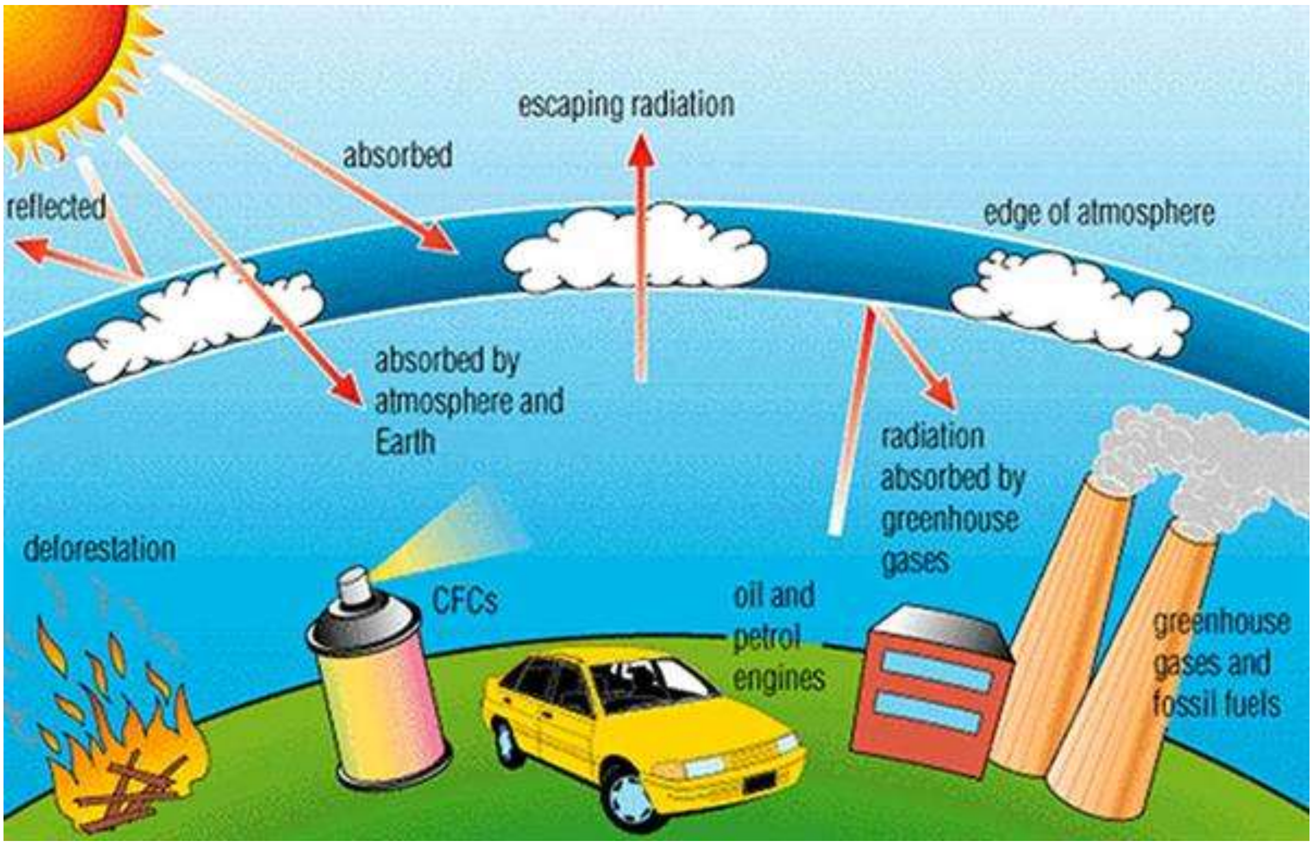
GHG Training

IPPU Background Information



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Aluminium Production

Aluminium production in South Africa is produced in reduction plants or smelters, where pure aluminium is extracted from alumina using the Hall-Héroult process. The demand for refined aluminium is driven by the transport sector, packaging sector and the construction

Questions

The table below summarizes the production of Aluminium in Tonnes for the period 2000 to 2009. Based the information that is provided in the table below, answer the following questions

a) Estimate the CO_2 emissions associated aluminium production for the period 2000 – 2009

b) Determine other process emissions except CO2 that are associated with Aluminium production and estimate the emissions

c) Estimate the CO_2e from aluminium production for the period 2000 - 2009

Table 1 Aluminium Production for the period 2000 to 2009

Aluminium Production (Tonnes)										
Summary	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Prebake	586 868	573 285	623 778	629 668	778 067	784 638	800 668	808 630	788 859	811 324
Soderberg	89 572	85 973	82 749	89 037	88 644	86 529	90 082	91 334	22 722	20 000
CWPB	586 868	573 285	623 778	629 668	778 067	784 638	800 668	808 630	788 859	811 324
SWPB	9980	9763	9192	10084	9784	10002	9974	9925	8040	7500
VSS	79 592	76 210	73 557	78 952	78 860	76 527	80 108	81 409	21 917	15 000

Carbon Black Production

Carbon black is produced from petroleum – based or coal-based feedstocks using the furnace black process.

The table below summarizes Carbon Black production in Tonnes for the period 2000 to 2009, answer the following questions.

a) Estimate the GHG emissions associated with carbon black production for the period 2000 - 2009

b) Estimate the CO_2e from carbon black production for the period 2000 – 2009

Carbon Black Production (Tonnes)										
Summary	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Furnace Black	52 917	52 917	61 862	61 464	60 976	57 662	54 071	57 686	51 187	51 187

Cement Production

The most common materials used for cement production are limestone, shells, and chalk or marl combined with shale, clay, slate or blast furnace slag, silica sand, iron ore and gypsum. For certain cement plants, low-grade limestone appears to be the only raw material feedstock for clinker production

According to the cement industry, South Africa imports approximately 10% the total cement, and exports 15%. In South Africa the clinker fraction is 0.73. The table below gives a summary of the total cement produced, imported and exposed. Answer the following questions

a) Estimate the amount of cement produced

b) Estimate the amount of cement exported

c) Estimate the amount of cement imported

d) Estimate the total GHG emissions associated with the production of cement in SA.

e) Estimate the CO2e associated with cement production

f) Repeat the above calculations assuming that in this case the clinker fraction is unknown and compare the results

Table 2 Cement production for the period 2000 to 2009

Cement Production (Kilo tonnes)										
Summary	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cement	8499	8703	8857	9430	10129	11384	11979	12921	12766	12379

Ferroalloys

Ferroalloys refer to concentrated alloys of iron and one or more metals such as silicon, manganese, chromium, molybdenum, vanadium and tungsten. Ferroalloy plants manufacture concentrated compounds that are delivered to steel production plants to be incorporated in alloy steels.

The table below gives a summary of Ferroalloy production in kt for the period 2000 to 2009, answer the following questions:

a) Estimate the CO2 and CH4 emissions associated with ferroalloy production for the period 2000 – 2009

b) Estimate the CO_2e for ferroalloy production for the period 2000 – 2009

Table 3 Ferroalloy Production

Ferroalloy Production (Kilo Tonnes)										
Summary	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Chromium Alloys (tonnes)	574	560	580	600	750	740	800	700	690	450
Manganese Alloys (7% C)	596	523	618	607	611	570	656	698	502	274
Manganese Alloys (1% C)	310	259	315	313	373	275	277	327	259	117
Sillicon Alloys (Assume 65% Si)	108	107	141	135	140	127	148	139	134	110
Silicon Metal	40	39	42	48	50	53	53	50	51	38

Iron and Steel Production

The production of Iron and Steel is summarised in the table below. It has been assumed that 35% was produced through the Basic Oxygen Furnace, 11% was produced through the Electric Arc Furnace, 0.29% was through Pig Iron Production, 12% was through Direct Reduced Iron Production and 41% through sinter production.

Based on the information provided, answer the following questions:

a) Determine the emission factors associated with the production of Iron and Steel through all the different methods;

b) Calculate the GHG emissions associated with the production of Iron and Steel through all the different methods

c) Estimate the total GHG emissions associated with the production of Iron and Steel.

d) Estimate the CO_2e for iron and steel production

Table 4 Iron and Steel Production

Iron and Steel Production (kt)										
Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Iron and Steel Production	5 775	11 431	11 449	12 434	12 589	13 112	12 902	11 754	10 543	8 983

Lead Production

There are two primary processes for the production of lead bullion from lead concentrates:

- Sintering/smelting (which consists of sequential sintering and smelting steps and constituents approximately 7% of the primary production.
- Direct smelting which eliminates the sintering step and is mainly 22% of the primary lead production.

Using the information provided answer the following questions

a) Estimate the CO_2 emissions associated with the production of lead

b) Estimate the CO_2 emissions in Gg

Table 5 Lead Production

Lead Production (kt)										
Summary	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Lead	75	51	50	40	37	42	48	42	46	49

Lime Production

Lime is the most widely used chemical alkali in the world. Calcium oxide (CaO or quicklime or slacked lime) is sourced from calcium carbonate ($CaCO_3$), which occurs naturally as limestone ($CaCO_3$) or dolomite ($MgCO_3$).

According to DMR, South Africa's local volumes of lime have been decreasing at an annual average of 5%, Quicklime and hydrated lime contributed 92% and 8% respectively. In the year 2000, 15,134,015 tonnes of lead was produced. Based the information provided answer the following questions:

a) Estimate the total lime produced for the years 2001 to 2009

b) Estimate the total quicklime produced

c) Estimate the total hydrated lime produced

d) Estimate the GHG emissions associated with the different types of lime

Zinc Production

There are three primary processes for the production of zinc:

- Electro – thermic distillation, this is a metallurgical process that combines roasted concentrate and secondary zinc products into sinter, that is combusted to remove zinc, halides, cadmium and other impurities. The reduction results in the release of non-energy CO_2 emissions.

- Pyrometallurgical process, this process involves the utilization of Imperial Smelting furnace, which allows for the simultaneous treatment of zinc and zinc concentrates. The process results in the simultaneous production of lead and zinc and the release of non-energy CO_2 emissions.

- Electrolytic, this process is a hydrometallurgical technique. During this process, zinc sulphide is calcinated, resulting in the production of zinc oxide. The electrolytic process does not result in non-energy CO_2 emissions.

The table below provides a summary for zinc production, using the information provided answer the following questions

a) Estimate the CO2 emissions associated with zinc production

b) Estimate the total GHG emissions in Gg from zinc production for the period 2000 to 2009

Zinc Production (kt)										
Summary	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Zinc	113	110	113	113	112	108	101	97	91	92

Solvent Use

The use of solvents can result to evaporative emissions of various non-methane volatile organic compounds, which can be oxidized and released into the atmosphere

Using energy balances provided, identify the solvent use for the period 2000 to 2009.

a) Using the IPCC guidelines convert the mass units of solvents to energy units

b) Based on the results above estimate the GHG emissions associated with the production of solvents and present them in Gg.

Carbide production

Calcium carbide is manufactured by heating calcium carbonate (limestone) and subsequently reducing CaO with carbon (e.g. petroleum coke).

a) Based on the information provided, estimate the GHG emissions associated with carbide production

Table 6 Carbide Production

Carbide Production (kt)										
Summary	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Carbide	12	18	40	43	38	48	45	48	49	47

Nitric acid and Ammonia production

Ammonia production is the most important nitrogenous material produced and is a major industrial chemical and Nitric acid is used as a raw material which is mainly used in the production of nitrogenous-based fertilizer.

Table 7 and Table 8 below give a summary of the production of ammonia and nitric acid respectively. Based on the information provided, answer the following questions;

a) Estimate the GHG emissions associated with ammonia production

b) Estimate the CO2e associated with ammonia production

c) Estimate the GHG emissions associated with nitric acid production

d) Estimate the CO2e associated with nitric acid production

Table 7 Production of Ammonia

Ammonia Production (Tonnes)										
Summary	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Ammonia	435	435	468	472	461	566	190	185	299	252

Table 8 Production of Nitric acid

Nitric Acid Production (Tonnes)										
Summary	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Nitric Acid	280	295	243	159	400	503	300	279	350	127

Titanium Oxide Production

Titanium dioxide (TiO_2) is a white pigment that is mainly used in paint manufacture, paper, plastics, rubber, ceramics, fabrics, floor covering, printing ink and other uses.

a) Based on the information provided, estimate the GHG emissions associated with titanium oxide production

Table 9 Titanium oxide production

Tonnes Titanium Dioxide production										
Period	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total	586	586	633	639	630	625	260	255	345	212

Substitute ODS

The Montreal Protocol on Substances that Deplete the Ozone Layer (a protocol to the Vienna Convention for the Protection of the Ozone Layer) is an international treaty designed to protect the ozone layer by phasing out the production of numerous substances believed to be responsible for ozone depletion.

The table below gives a summary of the substitute ODS that were imported and exported in SA for the period 2005 to 2009, based on the information provided answer the following questions.

a) Estimate the total substitute ODS consumed in SA

b) Determine the Emission factors for the substitute ODS mentioned in the table below

c) Estimate the GHG emissions associated with the consumption of substitute ODS in Sa for the period 2005 to 2009

d) Estimate the CO2e for the consumption of substitute ODS

Table 10 Substitute ODS

Substance	2005		2006		2007		2008		2009		2010	
	Import	Export	Import	Export	Import	Export	Import	Export	Import	Export	Import	Export
HFC-23	5.0	0.0	4.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.8	0.0
HFC-125	0.0	0.0	39.2	0.0	12.3	0.0	3.9	0.1	1.3	0.0	13.2	0.1
HFC-134a	643.0	0.0	442.0	0.0	750.0	0.0	713.9	17.8	777.9	34.0	1,426.8	3.6
HFC-143a	0.0	0.0	79.0	0.0	14.2	0.0	22.5	0.5	5.8	0.0	44.8	0.1
HFC-152a	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HFC-227	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0

Annexure A

Calorific Values for Fuels

A net Calorific value refers to the amount of heat liberated by the complete combustion, under specified conditions, of unit volume of a gas, the water produced by the combustion of the gas being assumed to remain as a vapour, the other products of combustion being referred to the standardized test conditions as applied in different countries. Hence the net calorific value is the gross calorific value less the latent heat of evaporation of the water that formed during combustion of the fuel. The table below gives a summary of the net calorific value for different fuels.

Table 11 Net Calorific Values for Fuels

Types of Fuel	Net Calorific Value for Fuels (TJ/L)
Petrol	0.0000342
Diesel	0.0000381
Jet Fuel	0.0000343
Paraffin	0.000037
Fuel Oil	0.0000416
Bitumen	0.0000402
LPG	0.0000267
Natural Gas	1

GWP Units, factors and abbreviations

Multiplication factor	Abbreviation	Prefix	Symbol
1 000 000 000 000 000	1015	Peta	P
1 000 000 000 000	1012	Tera	T
1 000 000 000	109	Giga	G
1 000 000	106	Mega	M
1 000	103	Kilo	k

100	102	Hector	h
0,1	10-1	Deci	d
0,01	10-2	Centi	c
0,001	10-3	Milli	m
0,000, 001	10-6	Micro	µ

Unit	Equivalency
1 tonne (t)	1 Megagram (Mg)
1 Kilotonne	1 Gigagram (Gg)
1 Megatonne	1 Teragram (Tg)

Table 12 Global Warming Potential of greenhouse gas gases (Source: FCCC/CP/2002/8, p.15).

Greenhouse gas	Chemical formula	1995 IPCC GWP
Carbon dioxide	CO_2	1
Methane	CH_4	23
Nitrous oxide	N_2O	296
Hydrofluorocarbons (HFCs)		
HFC-23	CHF_3	11 700
HFC-32	CH_2F_2	650
HFC-41	CH_2F	150
HFC-43	$C_5H_2F_{10}$	300
Perfluorocarbons (PFCs)		
Perfluoromethane	CF_4	6 500
Perfluoroethane	C_2F_6	9 200
Perfluoropropane	C_3F_8	7 000
Perfluorobutane	C_4F_{10}	7 000
Perfluorocyclobutane	$c\text{-}C_4F_8$	8 700

Greenhouse gas	Chemical formula	1995 IPCC GWP
Perfluoropentane	C_5F_{12}	7 500
Perfluorohexane	C_6F_{14}	7 400
Sulphur hexafluoride		
Sulphur hexafluoride	SF_6	23 900