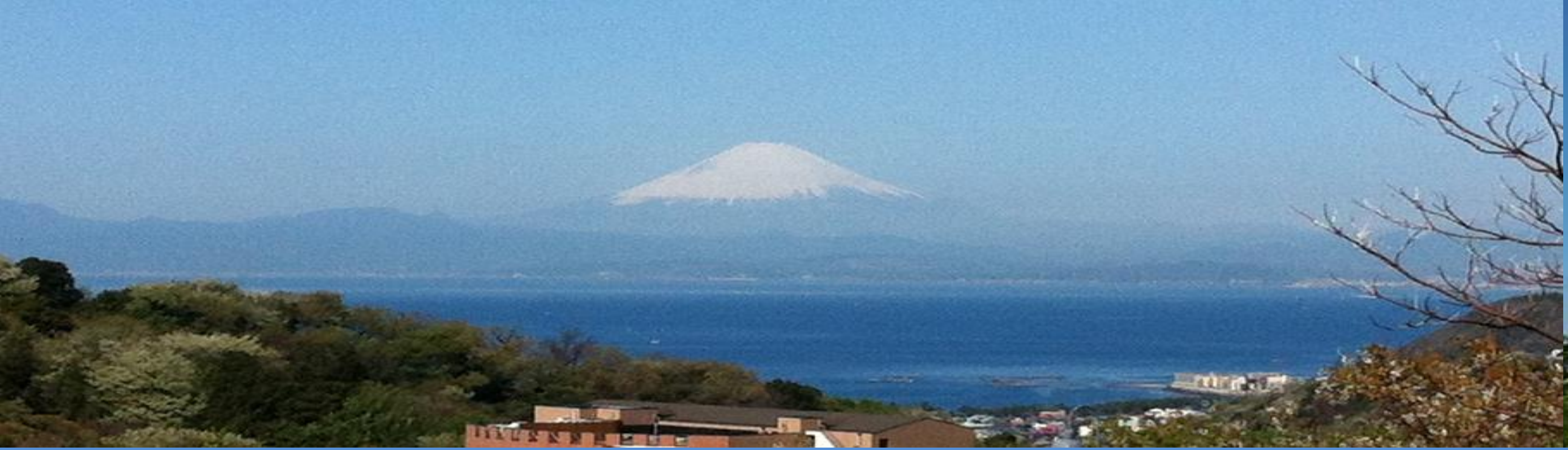

Industrial Processes and Product Use (IPPU)

Examples of Dummy Data Input

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IPCC TFI TSU

Baku, Azerbaijan – 4-6 Septemebr 2024

INTERGOVERNMENTAL PANEL ON climate change

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Importance of IPPU Sector

- Emissions from IPPU typically less significant compared to Energy and AFOLU
- Situation varies from country to country
- IPPU sources may become significant in the future as developing countries' economies and industries grow
- Inclusion of F-gases estimates can contribute significantly to the IPPU emissions and influence the key category analysis and total estimates
- IPPU emissions estimation is important to find opportunities for GHG abatement

Goals for IPPU Session

- Get familiar with the IPCC Inventory Software environment
  - Navigate the software interface and worksheets
  - Enter activity data and select emissions factors for selected categories
  - Use the F-gases Manager
- Be able to estimate emissions using the IPCC Inventory Software
  - Estimate GHG emissions from Cement Production (Tiers 1, 2 and 3)
  - Estimate CO_2 capture
  - Estimate GHG emissions from Iron and Steel Production (Tiers 1 and 2/3)
  - Set up the F-gases Manager
  - Estimate GHG emissions from Refrigeration and Air Conditioning (Tiers 1 and 2)

Approach to IPPU Session

- Morning Session

We will be working together from 09:00 to 12:30, 3-hours of knowledge and hands-on activities

✓ Cement, Iron and Steel, Petrochemicals

- Afternoon Session

We will be working together from 14:00 to 17:30, 3-hours of knowledge and hands-on activities

✓ Populating F-gases Manager and Refrigeration and Air Conditioning

- Step-by-step Guidance and Hands-On Practice
- Guided exercises to build familiarity and confidence with the IPCC Inventory Software. Data are appended to this presentation.

Background Reading

- Cement Production: Estimate process-related
  - ✓ Background – Vol. 3, chapter 2 of 2006 IPCC Guidelines
- Iron and Steel
  - ✓ Background – Vol. 3, chapter 4 of 2006 IPCC Guidelines
- Refrigeration and Air Conditioning
  - ✓ Background – Vol. 3, chapter 7 of 2006 IPCC Guidelines

Data for IPPU Exercises

2.A.1 Cement Production

Tier 1

Dummy Data – Tier 1

- There are two cement production companies in Country X (Company A and Company B).
  - Company A produced 2,534 kt of cement in 2015 and 3,112 kt in 2022.
    - ✓ Cement is a product mix, so called '30/70' *(30% portland cement and 70% blended cement) and 20% additives*
  - Company B produced 1,204kt of cement in 2015 and 4,205 kt in 2022.
    - ✓ Detailed information on cement type was not reported, but it is supposed that significant amounts of blended and/or masonry cements were produced in addition to portland cement *(i.e. blended/masonry was much).*
  - Company B exported 45 kt of clinker in 2015 and 67 kt in 2022 (there is no import)

Dummy Data – Tier 1

- **Estimate CO_2 emissions from cement production in Country X in 2015 and 2022.**
- As regards clinker fraction to be used in the calculation, see Table 2.2 from the *2006 IPCC Guidelines*

TABLE 2.2
CLINKER FRACTION OF BLENDED CEMENT 'RECIPES' AND OVERALL PRODUCT MIXES (BASED ON U.S. STANDARDS ASTM C-150 AND C-595; U.S. DATA MAY BE ILLUSTRATIVE FOR OTHER COUNTRIES)

Cement Name	Symbol	Recipe	% Clinker	Notes
Portland	'PC'	100% PC	95 - 97 90 - 92	Some U.S. states allow inclusion of 3% GGBFS. Latest standards allow inclusion of ≤ 5% ground limestone.
Masonry	'MC'	2/3 PC	64	varies considerably
Slag-modified portland	I(SM)	slag < 25%	>70 - 93	
Portland BF Slag	IS	slag 25-70%	28 - 70	
Portland pozzolan	IP and P	pozz 15-40%	28 - 79/81	base is PC and/or IS
Pozzolan-modified portland	I(PM)	pozz <15%	28 - 93/95	base is PC and/or IS
Slag cement	S	slag 70+%	<28/29	can use CaO instead of clinker

PERCENT CLINKER IN THE PRODUCT MIX

Percent Additives (Pozzolan + Slag) in the Blended Cement*

Product Mix (PC/blend)**	0%	10%	20%	30%	40%	75%
100/0	95 - 97	0	0	0	0	0
0/100	0	85.5	76	66.5	57	23.8
15/85	14.2	86.9	78.9	70.8	62.7	26.4
25/75	23.8	87.9	80.8	73.6	66.5	41.6
30/70	28.5	88.35	81.7	75.1	68.4	45.2
40/60	38	89.3	83.6	77.9	72.2	52.3
50/50	47.5	90.3	85.5	80.8 ***	76	59.4
60/40	57	91.2	87.4	83.6	79.8	66.5
70/30	66.5	92.2	89.3	86.5	83.6	73.6
75/25	71.1	92.6	90.1	87.8	85.4	77.1
85/15	80.8	93.6	92.2	90.7	89.3	84.3

Tier 2

2.A.1 Tier 2 – Clinker AD

- Company CementCarbo reports data based on clinker production. It produced 534 kt of clinker in 2015 and 612 kt in 2022.
- For estimation of CO_2 EF from clinker, use the default CaO content in clinker – 65%.
- For the data concerning the correction factor for cement kiln dust (CKD), see the table below (plant-specific data).

Parameter	2015	2022
Weight of CKD not recycled to the kiln (Md), tonne	65,230.0	74,940.0
Weight of clinker produced (Mcl), tonne	534,000.0	612000.0
Fraction of original carbonate in the CKD before calcination (Cd), fraction	1	1
Fraction calcination of the original carbonate in the CKD (Fd), fraction	1	1
Emission factor for the carbonate (EFc), tonne CO_2/ tonne carbonate	0.43971	0.43971
Emission factor for clinker uncorrected for CKD (EFcl), tonne CO_2/ tonne clinker	0.51044	0.51044

Tier 3

2.A.1 Tier 3 – Carbonates Input

- **Company CementPro reports data based on the amount of carbonates consumed in cement production process:**
  1. **Carbonates used:** amount of limestone (calcite - CaCO3) used – 12,45 kt in 2015 and 10.05 kt in 2022, calcination fraction achieved is assumed to be 100%
  2. **Correction for uncalcined CKD:** the amount of CKD not recycled to the kiln – 0.57 kt in 2015 and 0.51 kt in 2022, the weight fraction of original carbonate in the CKD not recycled to the kiln is assumed to be 100%, the calcination fraction is 0.99, the EF for Calcite is 0.43971 tonne CO_2/ tonne carbonate.
  3. **Additional carbon-bearing non-fuel materials – Kerogen:** the amount of kerogen used – 1,05 kt in 2015 and 0.5 kt in 2022, carbon content – 77%, the EF – 3.67 tonne CO_2/ tonne of carbon.

2.A.1 Cement Production

CO_2 Capture

2A1 – CO_2 Capture

- Company X captured at the cement plant 200kt of CO_2 for the subsequent geological storage and 25kt of CO_2 for use (for re-conversion to carbonates, for production of methanol, etc.) in 2015. For 2022, the amounts are the same.

2.C.1 Iron and Steel Production

Tier 1

Dummy Data – Tier 1

- There are two steel-making plants. They use two main steel-making processes:

i) Basic oxygen furnace (BOF), where 612kt of steel was produced in 2015 and 720 kt in 2022

ii) Open hearth furnace (OHF), where 425kt of steel was produced in 2015 and 312 kt in 2022.

Also, 182kt of sinter was produced in 2015 and 199 kt in 2022.

- Estimate CO_2 emissions from Iron and Steel Production in 2015 and 2022 *(as regards emission factors to be used in the calculation, see Table 4.1 of the 2006 IPCC Guidelines).*

TABLE 4.1
TIER 1 DEFAULT CO_2 EMISSION FACTORS FOR COKE PRODUCTION AND IRON & STEEL PRODUCTION

Process	Emission Factor	Source
Sinter Production (tonne CO_2 per tonne sinter produced)	0.20	Sinter Production: European IPPC Bureau (2001), Integrated Pollution Prevention and Control (IPPC) Best Available Techniques Reference Document on the Production of Iron and Steel, December 2001, Table 4.1, Page 29. http://eippcb.jrc.es/pages/FActivities.htm
Coke Oven (tonne CO_2 per tonne coke produced)	0.56	Coke Production: European IPPC Bureau (2001), Integrated Pollution Prevention and Control (IPPC) Best Available Techniques Reference Document on the Production of Iron and Steel, December 2001, Table 6.2, Page 122. http://eippcb.jrc.es/pages/FActivities.htm
Iron Production (tonne CO_2 per tonne pig iron produced)	1.35	Iron Production: European IPPC Bureau (2001), Integrated Pollution Prevention and Control (IPPC) Best Available Techniques Reference Document on the Production of Iron and Steel, December 2001, Tables 7.2 and 7.3. http://eippcb.jrc.es/pages/FActivities.htm
Direct Reduced Iron production (tonne CO_2 per tonne DRI produced)	0.70	Direct Reduced Iron Production: European IPPC Bureau (2001), Integrated Pollution Prevention and Control (IPPC) Best Available Techniques Reference Document on the Production of Iron and Steel, December 2001, Table 10.1 Page 322 and Table 10.4 Page 331. http://eippcb.jrc.es/pages/FActivities.htm
Pellet production (tonne CO_2 per tonne pellet produced)	0.03	Pellet Production: European IPPC Bureau (2001), Integrated Pollution Prevention and Control (IPPC) Best Available Techniques Reference Document on the Production of Iron and Steel, December 2001, Table 5.1 Page 95. http://eippcb.jrc.es/pages/FActivities.htm
Steelmaking Method		
Basic Oxygen Furnace (BOF) (tonne CO_2 per tonne of steel produced)	1.46	Steel Production: Consensus of experts and IISI Environmental Performance Indicators 2003 STEEL (International Iron and Steel Institute, 2004)
Electric Arc Furnace (EAF) (tonne CO_2 per tonne of steel produced) **	0.08	Steel Production: Consensus of experts and IISI Environmental Performance Indicators 2003 STEEL (International Iron and Steel Institute, 2004)
Open Hearth Furnace (OHF) (tonne CO_2 per tonne of steel produced)	1.72	Steel Production: Consensus of experts and IISI Environmental Performance Indicators 2003 STEEL (International Iron and Steel Institute, 2004)
Global Average Factor (65% BOF, 30% EAF, 5% OHF)* (tonne CO_2 per tonne of steel produced)	1.06	Steel Production: Consensus of experts and IISI Environmental Performance Indicators 2003 STEEL (International Iron and Steel Institute, 2004)

2.C.1 Iron and Steel Production

Tier 2/3

Dummy Data – Tier 2/3

- Company ZZZ reports the following input and output materials (in tonnes) in 2015 and 2022:

Input materials	2015	2022	Output Materials	2015	2022
Coke	360 000	450 000	Steel	1 020 000	1 275 000
Coal	160 000	200 000	Iron	980 000	1 225 000
Limestone	75 000	94 000	BFG	5 500 GJ	6 875 GJ
Dolomite	1 000	1 250	*All values are in tonnes, except BFG in GJ*		
Natural Gas	2 200	2 750			
COG	11 000	13 750			

- Assume user applies all IPCC default carbon contents, see Table 4.3 of the *2006 IPCC Guidelines*
- Estimate CO_2 emissions from Iron and Steel Production
- Also, let's tick the *biogenic* component and see the different results

TABLE 4.3
TIER 2 MATERIAL-SPECIFIC CARBON CONTENTS FOR IRON & STEEL AND COKE PRODUCTION (kg C/kg)

Process Materials	Carbon Content
Blast Furnace Gas	0.17
Charcoal*	0.91
Coal[1]	0.67
Coal Tar	0.62
Coke	0.83
Coke Oven Gas	0.47
Coking Coal	0.73
Direct Reduced Iron (DRI)	0.02
Dolomite	0.13
EAF Carbon Electrodes[2]	0.82
EAF Charge Carbon[3]	0.83
Fuel Oil[4]	0.86
Gas Coke	0.83
Hot Briquetted Iron	0.02
Limestone	0.12
Natural Gas	0.73
Oxygen Steel Furnace Gas	0.35
Petroleum Coke	0.87
Purchased Pig Iron	0.04
Scrap Iron	0.04
Steel	0.01

Source: Default values are consistent with the those provided in Vol 2 and have been calculated with the assumptions below. Complete references for carbon content data are included in Table 1.2 and 1.3 in Volume 2, Chapter 1.

Notes:

[1] Assumed other bituminous coal

[2] Assumed 80 percent petroleum coke and 20 percent coal tar

[3] Assumed coke oven coke

[4] Assumed gas/diesel fuel

* The amount of CO_2 emissions from charcoal can be calculated by using this carbon content value, but it should be reported as zero in national greenhouse gas inventories. (See Section 1.2 of Volume 1.)

Coke Production – Tier 1

(to be reported in Energy – 1.A.1.c)

Dummy Data – Tier 1

- Region North produced 45 kt of coke and Region South produced 1.2 kt of coke in 2015. In 2022 – 61 kt and 1.9 kt respectively.
- Estimate CO_2 and CH_4 emissions from Coke Production. As regards emission factors to be used in the calculation, see the Tables 4.1 and 4.2 from the *2006 IPCC Guidelines*.
- **Track CO_2 and CH_4 emissions from Coke Production in Reporting tables !**

Tier 1 default CO_2 emission factor

TABLE 4.1
TIER 1 DEFAULT CO_2 EMISSION FACTORS FOR COKE PRODUCTION AND IRON & STEEL PRODUCTION

Process	Emission Factor	Source
Coke Oven (tonne CO_2 per tonne coke produced)	0.56	Coke Production: European IPPC Bureau (2001), Integrated Pollution Prevention and Control (IPPC) Best Available Techniques Reference Document on the Production of Iron and Steel, December 2001, Table 6.2, Page 122. http://eippcb.jrc.es/pages/FActivities.htm

Tier 1 default CH_4 emission factor

TABLE 4.2
TIER 1 DEFAULT CH_4 EMISSION FACTORS FOR COKE PRODUCTION AND IRON & STEEL PRODUCTION

Process	Emission Factor	Source
Coke Production	0.1 g per tonne of coke produced	Coke Production: European IPPC Bureau (2001), Integrated Pollution Prevention and Control (IPPC) Best Available Techniques Reference Document on the Production of Iron and Steel, December 2001, Table 6.2-3, Page 122. http://eippcb.jrc.es/pages/FActivities.htm

Tier 1

Exercise: Customize F-gases Manager

- Country imports F-gases, and the blend R410A.
- No production/export of F-gases.
- List includes all F-gases/blends emitted in any year of time series.
- The following information is known about the use of the different gases/blends in different applications.
- Exercise: Please set up the F-gases Manager at the national level for this scenario.

F-gases Consumed	Electronics	Refrigeration and Air Conditioning	Fire protection	Aerosols	Soundproof windows
HFCs					
HFC-23	X	X			
HFC-32		X			
HFC-125		X			
HFC-134a		X		X	
HFC-143a		X			
HFC-152a		X			
HFC-227ea			X	X	
PFCs					
CF4	X				
C2F6	X				
c-C4F8	X				
SF6	X				X
NF3	X				
Blends					
R410A		X			

Exercise: Estimate 2.F.1.using Tier 1 Method

Exercise #1a: Set up the IPCC category level F-gases Manager

Recall earlier dataset and the F-gases consumed for RAC. The user should populate the IPCC category level F-gases Manager for 2.F.1.a.

- *Note that this is a category level Manager, so gases entered will be available for all subdivisions and Tier 2 calculations also.*

Indicate that HFC-152a is confidential.

In Exercise #1b the users will input all data for each gas/subdivision to estimate emissions.

F-gases Consumed	Electronics	Refrigeration and Air Conditioning	Fire protection	Aerosols	Soundproof windows
HFCs					
HFC-23	X	X			
HFC-32		X			
HFC-125		X			
HFC-134a		X		X	
HFC-143a		X			
HFC-152a		X			
HFC-227ea			X	X	
PFCs					
CF4	X				
C2F6	X				
c-C4F8	X				
SF6	X				X
NF3	X				
Blends					
R410A		X			

Exercise: Estimate 2.F.1.using Tier 1 Method

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Exercise 1b: Estimate emissions, in tonnes, for 2015 and 2022 for category 2.F.1.a, using the following data/assumptions:

- The country does not have any subdivisions.
- All gases/blends, except HFC-125, were introduced in 2000, HFC-125 introduced in 1995.
- Imported quantities for 2015 and 2022 are as shown.
- Equipment growth rate is 3.0%.
- No information is available on F-gas destruction at the end of life.
- IPCC defaults used for lifetime and EF from installed base.

F-gases Consumed	Refrigeration and Air Conditioning	Imports (t)	
		2015	2022
HFCs			
HFC-23	X	10	5
HFC-32	X	15	10
HFC-125	X	20	10
HFC-134a	X	5	20
HFC-143a	X	5	5
HFC-152a	X	5	5
Blends			
R410A	X	10	20

Hint! First enter the information for each chemical in **Chemical's Data,** then add the imports

2.F.1 Refrigeration and Air Conditioning

Tier 2

Exercise: Add gases for Tier 2 method

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Scenario: The user has already populated the IPCC **category level** F-gases Manager for the Tier 1 exercise. As the Manager is for category level, these F-gases/blends also appear for Tier 2.

However, assume that the user realizes that for the part of the country applying the Tier 2 method, C_2F_6 is also imported for industrial refrigeration.

Exercise #2a: Modify the IPCC category level F-gases Manager to include C_2F_6 emissions for category 2.F.1.

F-gases Consumed	Electronics	Refrigeration and Air Conditioning	Fire protection	Aerosols	Soundproof windows
HFCs					
HFC-23	X	X			
HFC-32		X			
HFC-125		X			
HFC-134a		X		X	
HFC-143a		X			
HFC-152a		X			
HFC-227ea			X	X	
PFCs					
CF4	X				
C2F6	X	X (added)			
c-C4F8	X				
SF6	X				X
NF3	X				
Blends					
R410A		X			

Exercise: Set Subdivision and sub-applications for Tier 2

The user has added all possible F-gases for Tier 2. Now it is time to create subdivisions in the country and identify the applications for calculating emissions

Exercise 2b:

Add two subdivisions for the country:

- ✓ "Capital city" and "Rest of country"
- ✓ For "Capital City" set the *Software* so that the following sub-applications exist:
  - ✓ Domestic Refrigeration
  - ✓ Medium & Large Commercial Refrigeration
  - ✓ Transport Refrigeration
  - ✓ Industrial Refrigeration including Food Processing and Cold Storage
  - ✓ Residential and Commercial A/C, including Heat Pumps
- ✓ No further modification for subdivision "Rest of country" needed for this exercise.

Note for Interoperability

Sub-application per IPCC	Mapping to CRT
Domestic Refrigeration	Maps to domestic refrigeration in CRT
Medium & Large Commercial Refrigeration	Maps to commercial refrigeration in CRT
Standalone commercial applications	
Chillers	
Industrial Refrigeration, incl. food processing and cold storage	Maps to industrial refrigeration in CRT
Transport Refrigeration	Maps to transport refrigeration in CRT
Residential and commercial A/C, incl heat pumps	Maps to stationary air conditioning in CRT
User defined sub-applications	

Exercise: Set EFs and parameters

This exercise will focus on adding EFs and parameters for one gas, in one sub-application, in one subdivision.

Exercise 2c:

In subdivision= Capital City

In sub-application= Domestic Refrigeration

Enter relevant information for gas = HFC-134a (not confidential)

Indicate use of the Tier 2a method

HINTs:

- ✓ Information added in worksheet **F-gas Parameters – Tier 2**
- ✓ Default data – See how data fall in ranges of Table 7.9 of the 2006 IPCC Guidelines and the EF for container management from equation 7.11.

Table 1

Sub-division:	Capital City	
Sub-application =	Domestic Refrigeration	
Gas=	HFC-134a	

Tier 2a parameters	Parameter name	Data
Year of introduction	t(stsart)	2000
EF for containers	EFc	2
EF for filling	EFk	0.5
EF for equipment operation	EFx	0.25
Lifetime	d	12
Share of initial charge remaining at end of life	ρ	80
Recovery efficiency	η (rec,d)	35

2.F.1: Enter AD and Estimate Emissions

Exercise 2d:

- Estimate emissions of HFC-134a, following Tier 2a method, for subdivision = capital city, sub-application = Domestic Refrigeration
- All consumption from imports (bulk and in equipment) ; no production or export.
- Assume input data were known for 2015 and 2022 (see table).
  - Note: The user did not want to use Tier 1 and decided to extrapolate existing AD to full time series, noting that there was a 2% change in AD between 2015 and 2022, the user extrapolated back the 2% to the year of introduction of the gas.
- No country-specific information on the amount of gas used to refill equipment versus for new equipment, so calculate with default.
- No data on destruction for each year.
- No export of gas in used equipment.

	Imports in bulk (kg)	Contained in factory-charged imported equipment (kg)
2000	3.7	0.7
2001	3.8	0.8
2002	3.9	0.8
2003	3.9	0.8
2004	4.0	0.8
2005	4.1	0.8
2006	4.2	0.8
2007	4.3	0.9
2008	4.4	0.9
2009	4.4	0.9
2010	4.5	0.9
2011	4.6	0.9
2012	4.7	0.9
2013	4.8	1.0
2014	4.9	1.0
2015	5.0	1.0
2016	5.1	1.0
2017	5.2	1.0
2018	5.3	1.1
2019	5.4	1.1
2020	5.5	1.1
2021	5.6	1.1
2022	5.7	1.1

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