2019 Refinement to the 2006 IPCC Guidelines: Refinements in Volume 3 (Industrial Process and Product Use)

Bonn Climate Change Conference (SB50)

SBSTA - IPCC Special Event on 2019 Refinement to the 2006 IPCC Guidelines

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What is IPPU?

Industrial Processes and Product Use (IPPU) – Greenhouse Gas (GHG) emissions (!):

1. *Industrial Processes*

   that chemically or physically transform materials releasing GHGs:

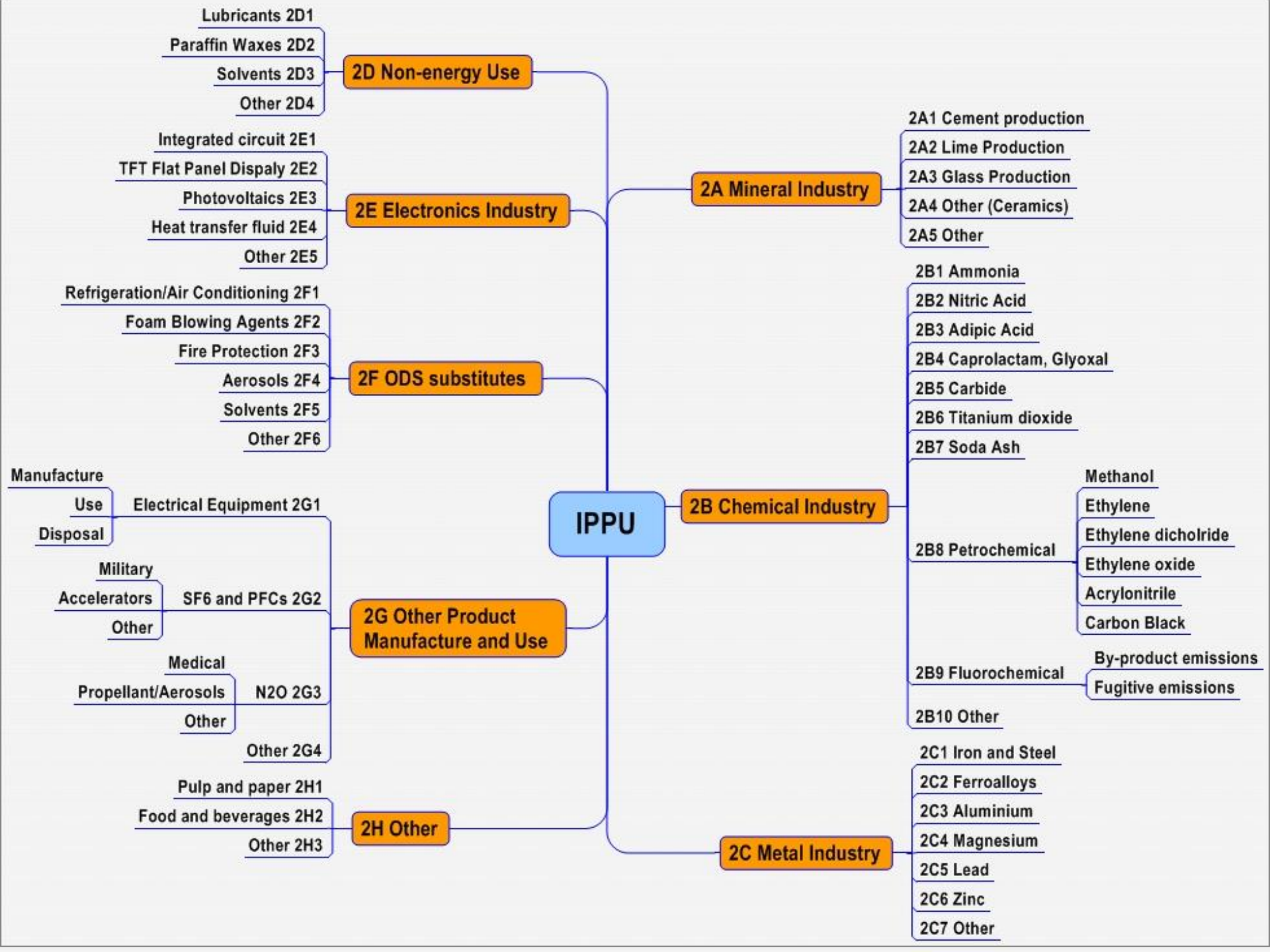
   - chemically: $NH_3 + O_2 = 0.5\ N_2O\uparrow + 1.5\ H_2O$ *(nitric acid production)*
   - physically: $CaCO_3 + (Heat) = CaO + CO_2\uparrow$ *(cement production)*

2. *Product Use*

   GHGs are used in products such as refrigerators, foams or aerosols

Note:

All emissions from combustion of fossil fuels in Industry are under Energy Sector. IPPU focuses on process emissions


IPPU
2A Mineral Industry
2A1 Cement production
2A2 Lime Production
2A3 Glass Production
2A4 Other (Ceramics)
2A5 Other
2B Chemical Industry
2B1 Ammonia
2B2 Nitric Acid
2B3 Adipic Acid
2B4 Caprolactam, Glyoxal
2B5 Carbide
2B6 Titanium dioxide
2B7 Soda Ash
2B8 Petrochemical
Methanol
Ethylene
Ethylene dicholride
Ethylene oxide
Acrylonitrile
Carbon Black
2B9 Fluorochemical
By-product emissions
Fugitive emissions
2B10 Other
2C Metal Industry
2C1 Iron and Steel
2C2 Ferroalloys
2C3 Aluminium
2C4 Magnesium
2C5 Lead
2C6 Zinc
2C7 Other
2D Non-energy Use
Lubricants 2D1
Paraffin Waxes 2D2
Solvents 2D3
Other 2D4
2E Electronics Industry
Integrated circuit 2E1
TFT Flat Panel Dispaly 2E2
Photovoltaics 2E3
Heat transfer fluid 2E4
Other 2E5
2F ODS substitutes
Refrigeration/Air Conditioning 2F1
Foam Blowing Agents 2F2
Fire Protection 2F3
Aerosols 2F4
Solvents 2F5
Other 2F6
2G Other Product Manufacture and Use
Electrical Equipment 2G1
Manufacture
Use
Disposal
SF6 and PFCs 2G2
Military
Accelerators
Other
N2O 2G3
Medical
Propellant/Aerosols
Other
Other 2G4
2H Other
Pulp and paper 2H1
Food and beverages 2H2
Other 2H3

Mandate for Refinement (IPPU)

Chapter 3
- Nitric acid production
- Fluorochemical production
- Hydrogen production *[New]*

Chapter 4
- Iron and Steel
- Primary aluminium production and Alumina production *[New]*
- Rare Earths elements *[New]*

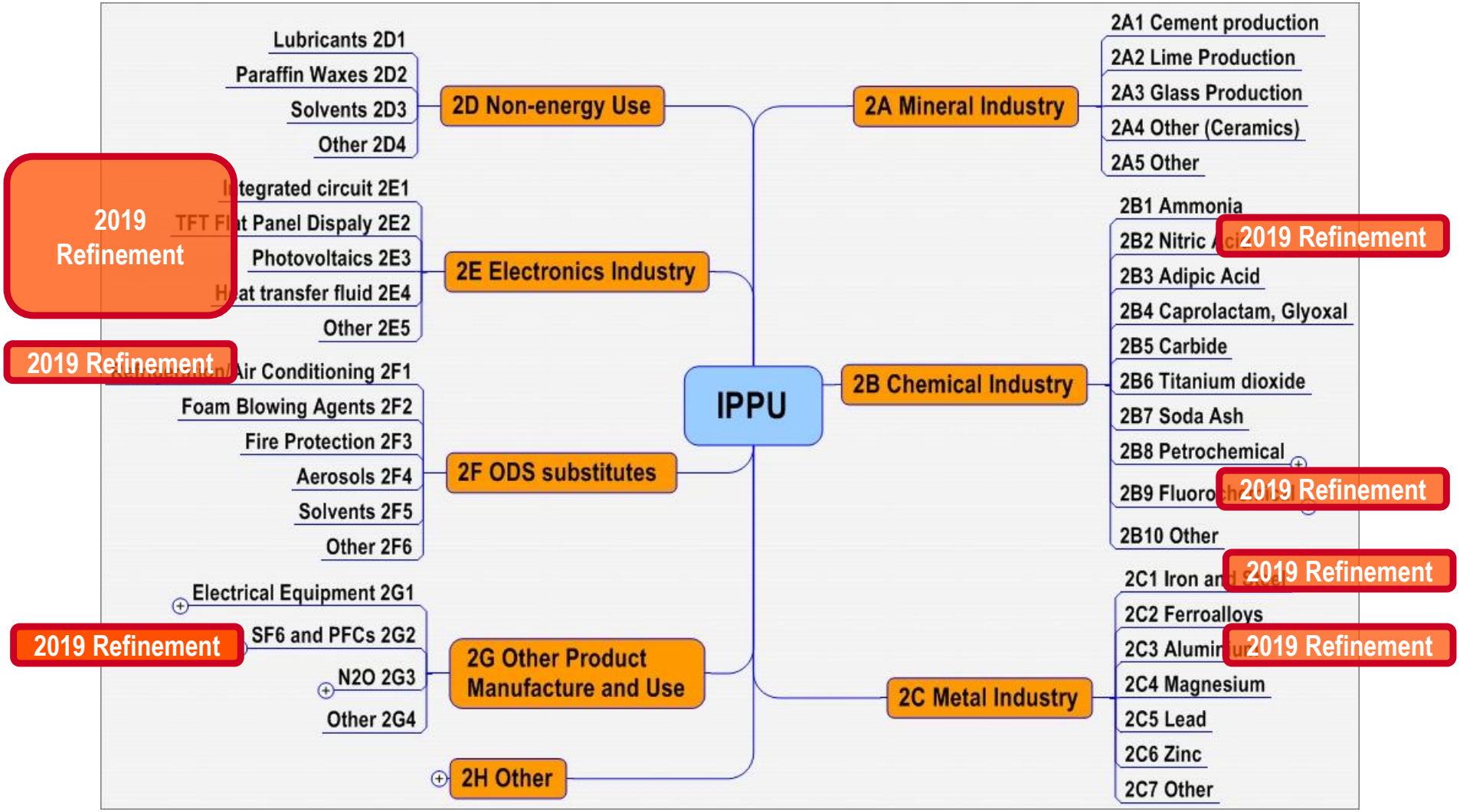
Chapter 6
- Electronics Industry

Chapter 7
- Refrigeration and air conditioning

Chapter 8
- Use of SF_6 and PFCs in Textile Industry and for Water-proofing of electronic circuit boards *[New]*

✓ *Decision IPCC/XLIV-5*
IPCC-44, Bangkok (Thailand), October 2016

IPPU Refinement – 2006 Structure



Nitric Acid Production – N_2O

Update of N_2O emission factors for various types of technologies used for Nitric Acid production:

- single-/duo- low-/medium- /high- pressure plants
- with or without abatement

TABLE 3.3 (UPDATED)
DEFAULT FACTORS FOR NITRIC ACID PRODUCTION

Production Process	N_2O Emission Factor (relating to 100 percent pure acid)
Old (pre-1975) plants* (all processes)	10-19 kg N_2O/tonne nitric acid[a]
Single low pressure plants	5 kg N_2O/tonne nitric acid ±10%
Single medium pressure plants	8 kg N_2O/tonne nitric acid ±20%[b]
Single high pressure plants	9 kg N_2O/tonne nitric acid ±40%
Single pressure plants with abatement technology**	2.5 kg N_2O/tonne nitric acid ±10%[b]
Dual Pressure (M/H)	9 kg N_2O/tonne nitric acid ±30%[b]
Dual Pressure (M/H) with abatement technology	2.5 kg N_2O/tonne nitric acid ±20%[b]
Dual Pressure (L/M)	7 kg N_2O/tonne nitric acid ±20%[b]
Dual Pressure (L/M) with abatement technology	1.5 kg N_2O/tonne nitric acid ±10%[b]

Fluorochemical Production

- Improved guidance on GHG emissions from production of fluorinated compounds (*other than HFC-23 emissions from HCFC-22 production*)
- These emissions include emissions of the intentionally manufactured chemical as well as reactant and by-product emissions.
  - For example, in a national inventory for a fluorochemical plant, significant by-product emissions of SF_6, CF_4, C_2F_6, C_3F_8, C_4F_{10}, C_5F_{12} and C_6F_{14} were reported
  - Other examples include the release of by-product N_2O and CF_4 from the production of NF_3
- Streamlined categories

2006 IPCC Guidelines		2019 Refinement	
2B9 Fluorochemical Production	2B9a By-Product emissions	2B9 Fluorochemical Production	2B9a HCFC-22 Production
	2B9b Fugitive emissions		2B9b HFC Production
			2B9c PFC Production
			2B9d SF_6 Production
			2B9e NF_3 Production
			2B9f Fluoropolymer Production
			2B9g Other Fluorochemical Production

Hydrogen Production – CO_2

- New category for stand-alone facilities which produce only Hydrogen as a main product
- Hydrogen can be produced in Refineries as well (*2006 IPCC Guidelines*)
- The method is similar to Methanol and Ammonia production – SynGas technology (steam reforming and gasification)
- Focus on fossil fuels (!) which provide Hydrogen and Carbon (subsequently CO_2)

Iron and Steel Production – CO_2

- Clarified guidance on demarcation between Energy and IPPU – all emissions from Coke Production emissions are in Energy (as in *2006 IPCC Guidelines*)
- Updated CO_2 emission factors
- Improvements on BFG/LDG flaring (CO_2, N_2O) and non-fugitives CH_4 emissions

Aluminium – PFCs (CF_4 and C_2F_6)

- CO_2 guidance is unchanged
- PFCs guidance is improved taking into account a new phenomena on the low-voltage anode effects (LVAE) added to previously known the high-voltage anode effect (HVAE)

TABLE 4.15 (UPDATED)
TECHNOLOGY SPECIFIC DEFAULT EMISSION FACTORS FOR THE CALCULATION OF HVAE AND LVAE EMISSIONS FROM ALUMINIUM PRODUCTION (TIER 1 METHOD) (MARKS & NUNEZ 2018B)

Technology	HVAE				LVAE	
	CF_4		C_2F_6		CF_4	
	EF_{CF4} (kg/tonne Al)	Uncertainty Range (%)[b]	EF_{C2F6} (kg/tonne Al)	Uncertainty Range (%)	EF_{CF4} (kg/tonne Al)	Uncertainty Range (%)
$PFPB_L$	0.016[a]	-82/+126[a]	0.001	-74/+109[a]	0.009[a]	+99/-61
$PFPB_M$	0.011	-90/+213	0.001	-90/+256	0.018	+247/-98
$PFPB_{MW}$	0.161[b]	-85/+476	0.013[b]	-98/+864	-	-
SWPB	0.354	-76/+116	0.093	-89/+68	0.010	+69/-69
VSS	0.159[c]	-94/+580[c]	0.009[c]	-94/+525	0.001	+61/-52
HSS	0.477	-79/+112	0.033	-76/+86	0.026	-[d]

Alumina Production – CO_2

- Methodological issues for particular technologies are only considered (Bayer-sintering parallel (BSP), Bayer-sintering sequential (BSS) and Nepheline processing (NP) – for Alumina Production)
- It is estimated that only around 3% of alumina was produced globally via the Bayer-sintering process and around 1% via the Nepheline processing mainly in 3 countries – Russia, Kazakhstan and China
- *2006 IPCC Guidelines* already considered fossil fuel combustion (Chapter 2 Volume 2) and lime production (Chapter 2 Volume 3). Check lime activity data for double counting!

TABLE 4.17A (NEW)
TECHNOLOGY SPECIFIC DEFAULT EMISSION FACTORS FOR THE CALCULATION OF CO_2 EMISSIONS FROM ALTERNATIVE SINTERING PROCESSES (TIER 1 METHOD)

Technology	$EF_{SintAl2O3}$ (tonne CO_2/tonne Al)[a]	Uncertainty Range (%)[b]
Bayer-sintering (BSP and BSS)	0.81	-8/+4
Nepheline-sintering process (NP)	2.46	-2/+4

Rare Earths Production – CO_2 and PFCs

- New category. Rare Earths Production is an electrolytic process similar to Aluminium Production
- Emissions of CO_2 and PFCs (CF_4, C_2F_6, C_3F_8)

TABLE 4.28 (NEW)
TIER 1 DEFAULT EMISSION FACTORS AND UNCERTAINTY RANGES FOR THE CALCULATION OF PFC EMISSIONS FROM RARE EARTH PRODUCTION

	CF_4		C_2F_6		C_3F_8	
Rare Earth Metal, *i*	**EF_{CF4} (g/tonne RE metal)**	**Uncertainty Range [c] (+/-%)**	**EF_{C2F6} (g/tonne RE metal)**	**Uncertainty Range [c] (+/-%)**	**EF_{C3F8} (g/tonne RE metal)**	**Uncertainty Range [c] (+/-%)**
RE-iron alloys (Dy-Fe, etc) [a]	146.1	+/- 99%	14.6	+/- 99%	0.05	+/- 99%
Other-RE metals/alloys (Nd, Pr-Nd, La, etc) [b]	35.8	-54% / +30%	5.2	-95% / +108%	0.21	-52% / +30%

Electronics Industry

- The guidance was substantially updated taking into account dynamic changes in the industry (production of semiconductors, displays, photovoltaics, etc.)
- The categories are almost the same with addition of Microelectromechanical systems. Fluorinated liquids are estimated under each sub-category
- Tier 1 and Tier 2 emission factors were updated with increased number of species
- Variety of gases (N_2O, SF_6, NF_3, HFCs, PFCs)

Refrigeration and Air Conditioning

- According to the mandate the guidance on "How to build a refrigeration and air conditioning emission inventory in a few simple steps" was developed
- Some updated information regarding emission factors for refrigerants (HFCs) was provided
- An example MS Excel worksheet was produced to facilitate emissions estimations for Tier 2

Other Product Manufacture and Use

Water-proofing of electronic circuit boards

Fluorinated compounds are used to waterproof electronic circuits (by gas-phase reaction in a plasma). The plasma deposition process involves the introduction of a variety of hydrocarbon gases, where the hydrogen atoms are replaced by fluorine supplied from a fluorinated gas source decomposed in a plasma. Periodically, the process chamber is also cleaned using fluorinated gases in a way similar to one in Electronics industry.

TABLE 8.11 (NEW)
EMISSION FACTOR FOR WATERPROOFING OF ELECTRONIC CIRCUITS

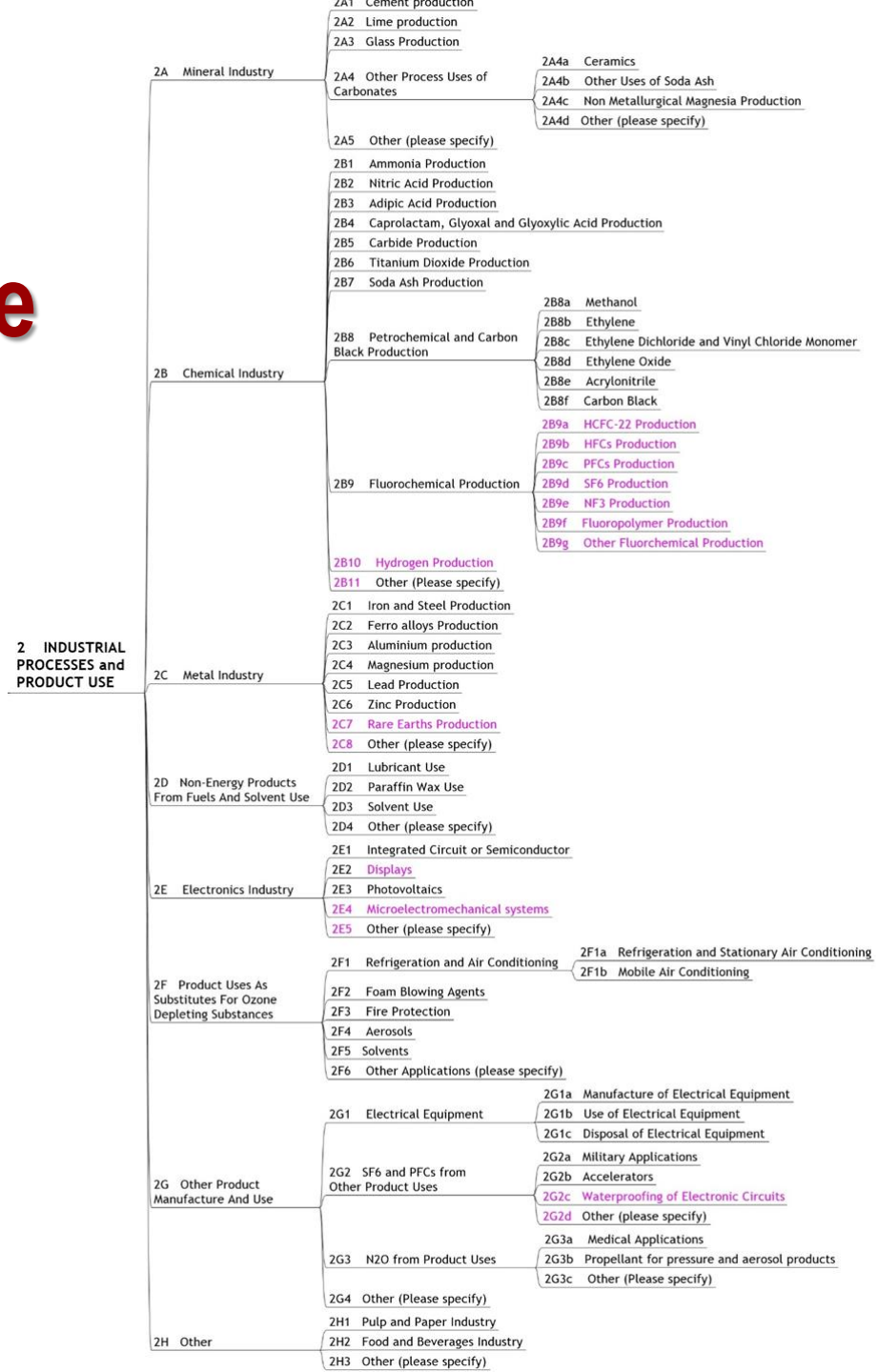
Gas Emitted	Emissions (g)/Circuit Board
CF_4	0.006
C_2F_6	0.004
CHF_3	0.003

Textile Industry

As in Electronics Industry, plasma-based processes using fluorinated compounds in the textile industry are expected to result in emissions of unreacted fluorinated compounds and by-products with high global warming potentials (GWPs). However, the extent to which plasma processes have been introduced in textile manufacturing is not clear. Also, the wet application of fluorinated compounds commonly used to treat textile, carpet, leather, and paper fibres can result in emissions of volatile fluorinated compounds through evaporative losses and cracking.

- *This guidance was moved to Appendix. Authors could not develop default emission factors for Textile Industry. Basis for future work*

New 2019 IPPU Structure



Conclusion

- Only particular categories were refined, where there is a need to update emission factors and methodological guidance and to provide new information
- More complete coverage of sources and gases, some of categories are minor ones in terms of emissions
- Structure of categories is practically the same. Main categories are already covered in *2006 IPCC Guidelines*
- F-gases emissions are evolving all the time (a challenge for developing emission factors). IPCC guidelines provide with default emission factors, countries can use their own factors

Thank you

https://www.ipcc-nggip.iges.or.jp/index.html

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