Data requirements and sourcing – Domestic Refrigeration and Air conditioning

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Contents

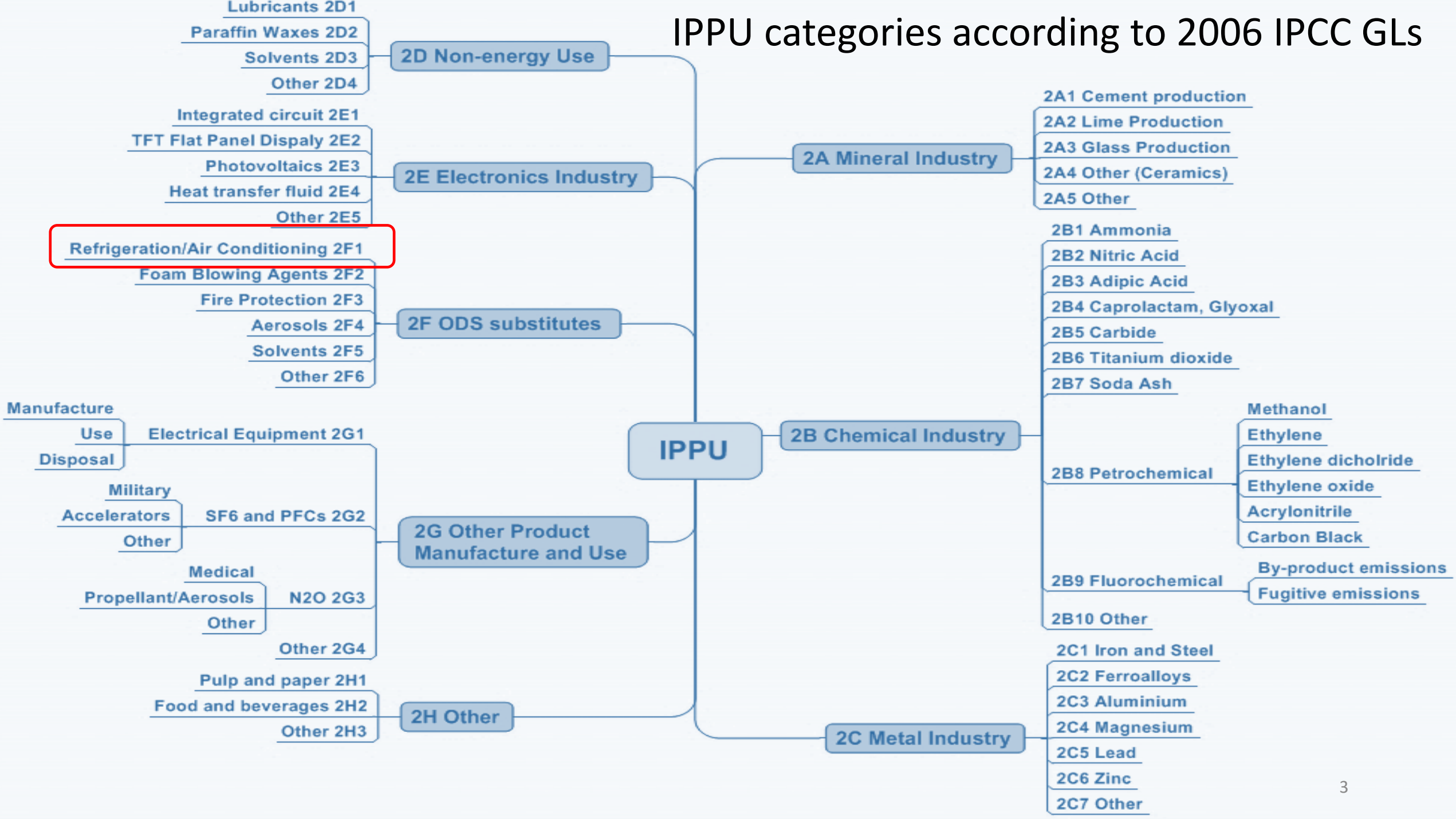
Introduction – project coverage for the IPPU sector

Key concepts for the 2.F.1 category

Methods and data requirements (tier 1)

Data use

IPPU categories according to 2006 IPCC GLs



Applications & sub-applications

TABLE 7.1
MAIN APPLICATION AREAS FOR HFCS AND PFCS AS ODS SUBSTITUTES [1]

Chemical	Refrigeration and Air Conditioning	Fire Suppression and Explosion Protection	Aerosols		Solvent Cleaning	Foam Blowing	Other Applications[2]
			Propellants	Solvents			
HFC-23	X	X					
HFC-32	X						
HFC-125	X	X					
HFC-134a	X	X	X			X	X
HFC-143a	X						
HFC-152a	X		X			X	
HFC-227ea	X	X	X			X	X
HFC-236fa	X	X					
HFC-245fa				X		X	
HFC-365mfc				X	X	X	
HFC-43-10mee				X	X		
PFC-14[3] (CF_4)		X					
PFC-116 (C_2F_6)							X
PFC-218 (C_3F_8)							
PFC-31-10 (C_4F_{10})		X					
PFC-51-14[4] (C_6F_{14})					X		

Sub-applications:

Example: refrigeration has six major subapplications:

- Domestic (i.e., household) refrigeration,
- Commercial refrigeration including different types of equipment, from vending machines to centralized refrigeration systems in supermarkets,
- Industrial processes including chillers, cold storage, and industrial heat pumps used in the food, petrochemical, and other industries,
- Transport refrigeration including equipment and systems used in refrigerated trucks, containers, reefers, and wagons,
- Stationary air conditioning including air-to-air systems, heat pumps, and chillers19 for building and residential applications,
- Mobile air-conditioning systems used in passenger cars, truck cabins, buses, and trains.2

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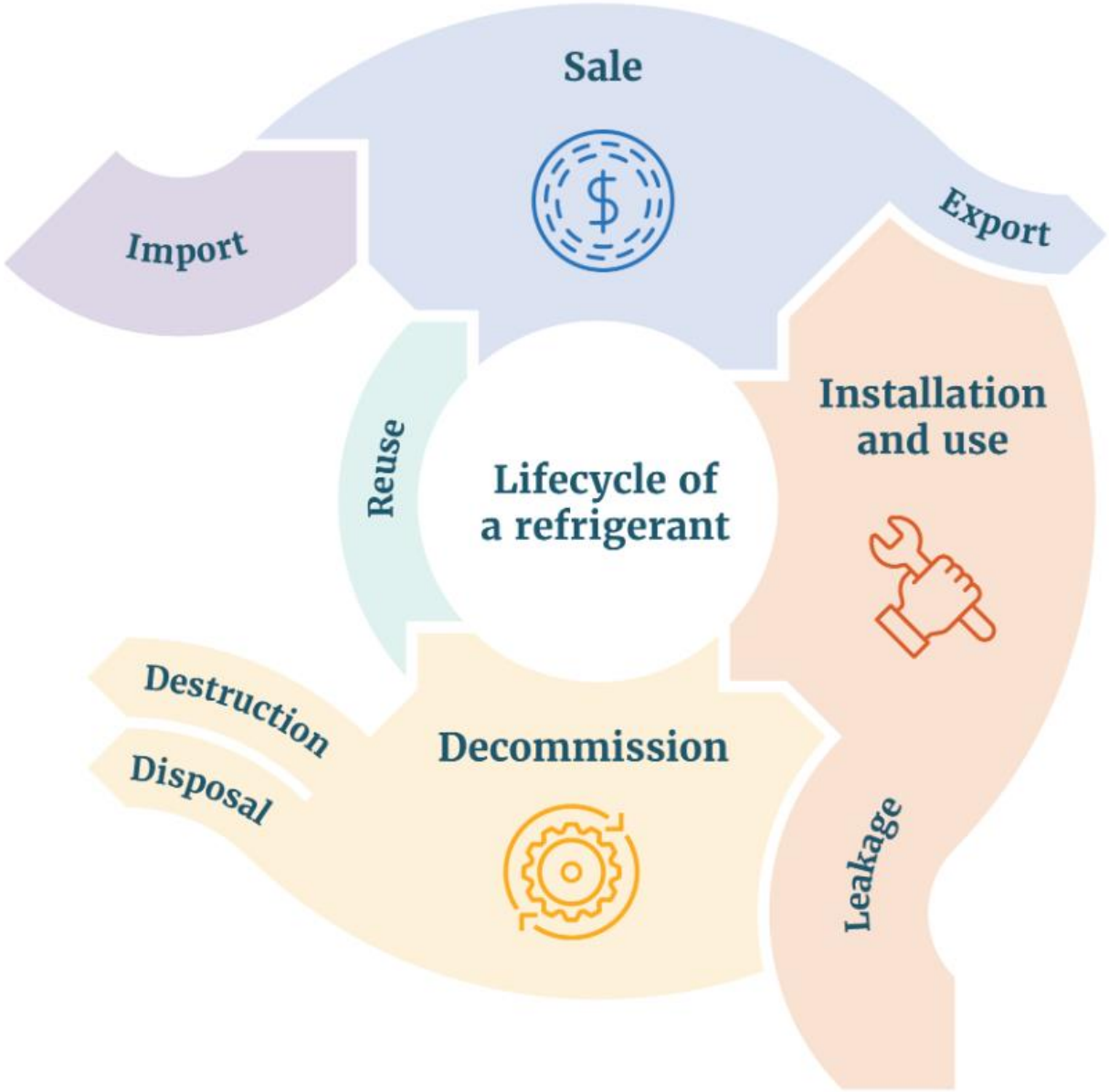
Lifecycle of a refrigerant

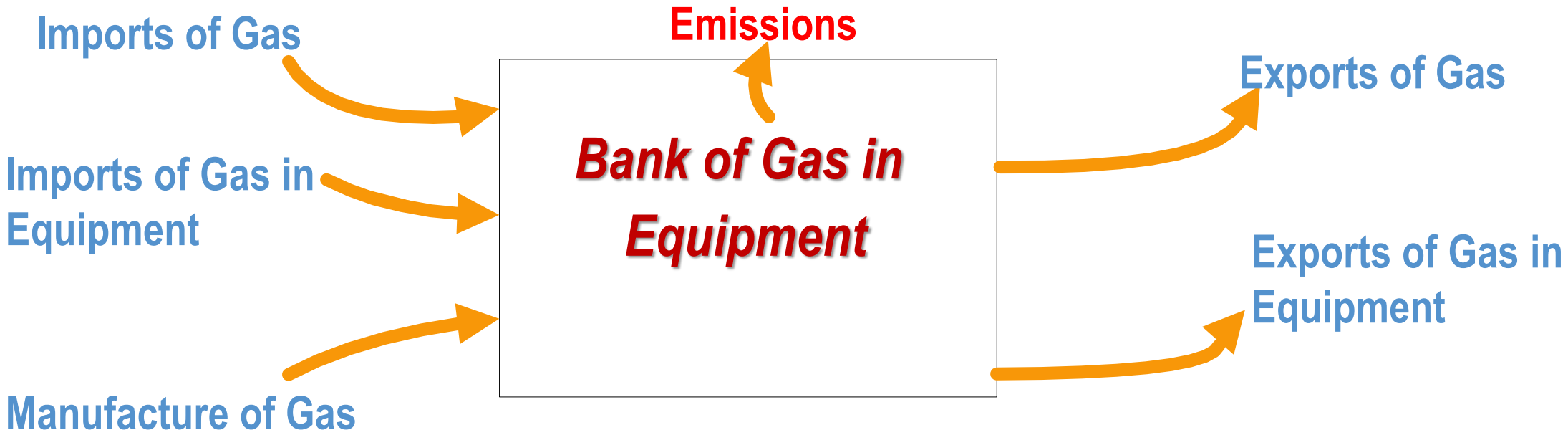


Bank

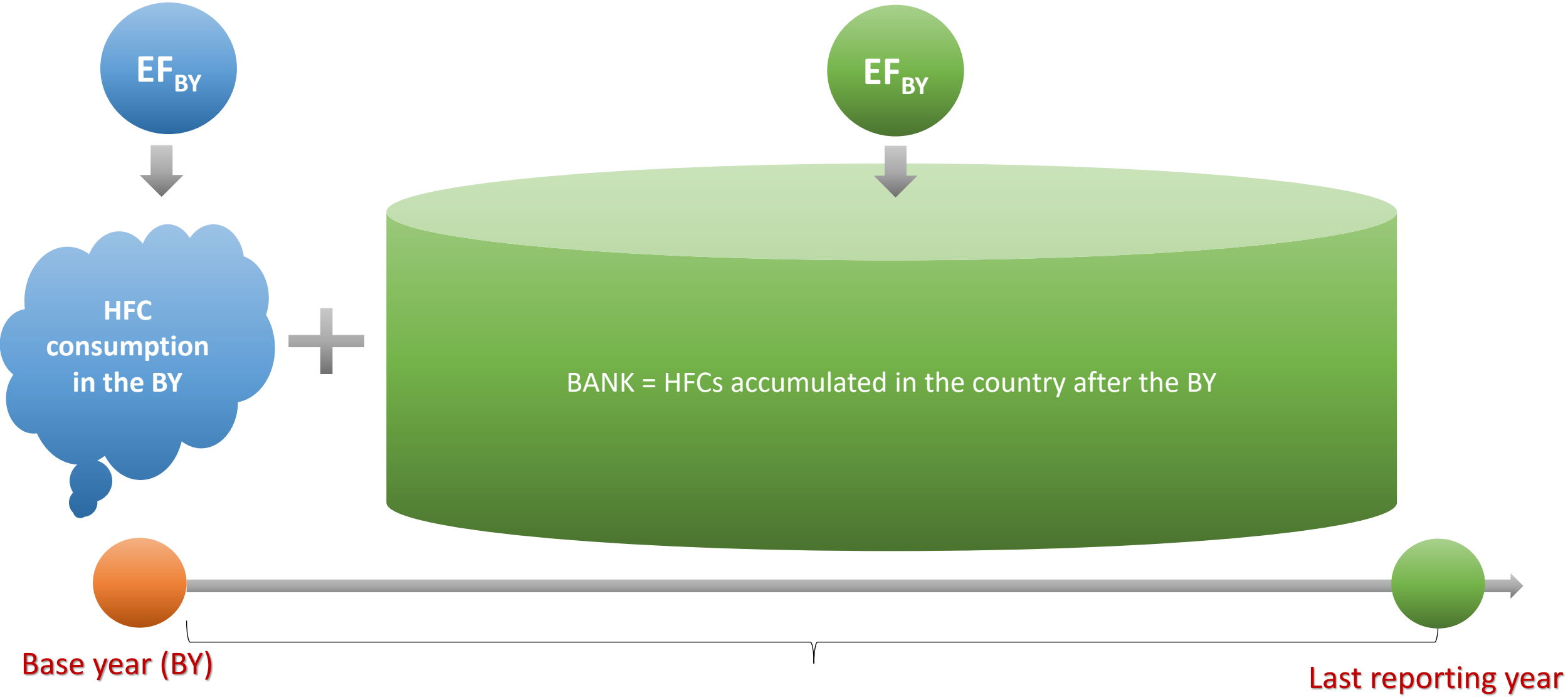
Prompt emissions - where emissions occur within the first two years, they are usually referred to as ***prompt*** emissions.

Delayed emissions - where emissions could occur after the 2-year period time (sometimes, they occur only at the equipment destruction stage) – e.g., refrigeration and air conditioning, fire protection, closed-cell foams, non-aerosol solvents

Bank = consumed gas that is not yet emitted



Estimating emissions from HFCs – key elements



Methodological approach

- Tier 1a
  - uses EFs, net consumption, and banks
- Tier 1b
  - uses mass balance
- Hybrid approach Tier 1a/b
  - Uses net consumption, banks, and EFs

Tier 1a method – net consumption, bank, and EF

In cases where banks occur:

EQUATION 7.2B
CALCULATION OF EMISSIONS OF A CHEMICAL FROM AN APPLICATION WITH BANKS

$$Annual\ Emissions = Net\ Consumption \bullet Composite\ EF_{FY} + Total\ Banked\ Chemical \bullet Composite\ EF_{B}$$

Net Consumption = net consumption for the application
Composite EF_{FY} = composite emission factor for the application for the first year
Total Banked Chemical = bank of the chemical for the application
Composite EF_{B} = composite emission factor for the application for the bank

EQUATION 7.1
CALCULATION OF NET CONSUMPTION OF A CHEMICAL IN A SPECIFIC APPLICATION

$$Net\ Consumption = Production + Imports - Exports - Destruction$$

Composite emission factors are determined by taking an average of the sub-application emission factors, weighted according to the activity in each sub-application. Sub-application emission factors can be country-specific or default.

Mass-balance approach (1b) basics

General mass balance equation for Tier 1b

$$Emissions = Annual\ Sales\ of\ New\ Chemical - (Total\ Charge\ of\ New\ Equipment - Original\ Total\ Charge\ of\ Retiring\ Equipment)$$

100 t = 80 t + 30 t - 10 t

F-gases =

All chemicals sold (in containers and in equipment)

+

Original amount in retired equipment (assuming the refrigerant will fully escape AFTER the retirement)

-

Total amount in new equipment

Hybrid approach 1 a/b: Emission factors and assumptions

The Tier 1a/b method back-calculates the development of banks of a refrigerant from the current reporting year to the year of its introduction.

Such a hybrid Tier 1a/b approach may use the following assumptions:

- **Emissions from banked refrigerants average** = **15%** annually across the whole RAC application area (This assumption is estimated to be a weighted average across all sub-applications, for which default emission factors are shown in Table 7.9)
- **Servicing of equipment** containing the refrigerant does not commence until **3 years** after the equipment is installed.
- In a mature market:
  - **2/3 (67%)** of the sales of a refrigerant are used for **servicing**
  - **1/3 (33%)** – is used to charge **new equipment**.
  - ***A mature market*** *is one in which ODS substitute-employing refrigeration equipment is in wide use, and there are relationships between suppliers and users to purchase and service equipment.*
- **The average equipment lifetime** – ***15 years***. This assumption is also estimated to be a weighted average across all sub-applications.
- **The complete transition** to a new refrigerant technology will take place over a ***10-year period***.
- This assumption is valid for a single chemical in a single country.

Data requirements for simplified IPCC tier 1/b approach

- Information on domestic **production, import, and export** of chemicals (=agents) in the year to be reported
- **Year of introduction** of the refrigerant
- **Growth rate** in sales of new equipment (usually assumed linear across the period of assessment)
- Assumed equipment lifetime (for household equipment the IPCC default is **15 years**)
- **Remaining Agent** in Retired Equipment (could be set at **0 if unknown**)
- **Destruction of agent** in retired equipment (could be set at **0 if unknown**)
- **Release of agent** from retired equipment (could be set at **0 if unknown**)

Example of data use in method 1a/b

HFC-143a

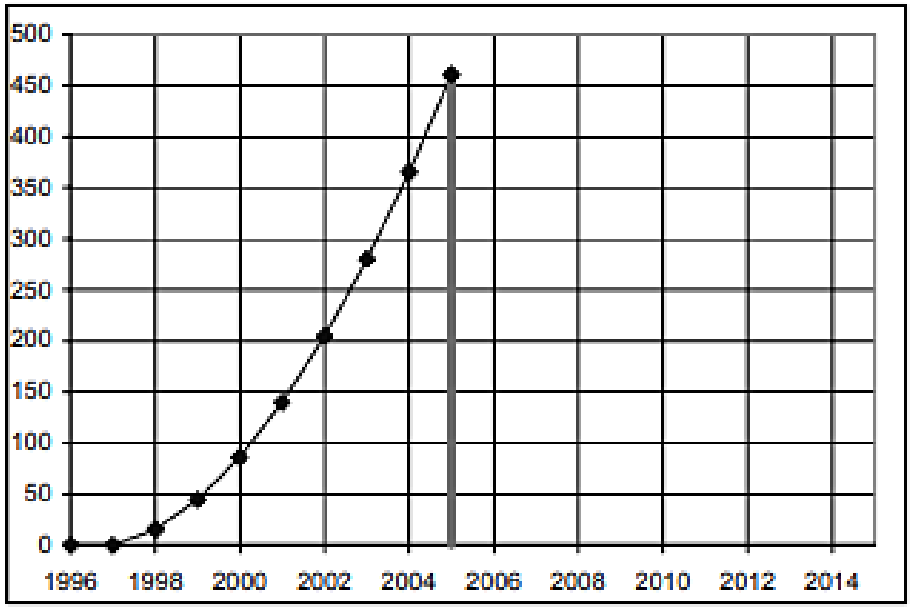
Agent: HFC-143a
Year: 2005
Emission: 460.7 tonnes
In Bank: 3071.1 tonnes

Current Year	2005

Use in current year - 2005 (tonnes)	Data Used Here
Production of HFC-143a	800
Imports in current Year	200
Exports in current year	0
Total new agent to domestic market	*1000*

Year of Introduction of HFC-143a	1998
Growth Rate in New Equipment Sales	3.0%

Tier 1 Defaults	
Assumed Equipment Lifetime (years)	15
Emission Factor from installed base	15%
% of HFC-143a destroyed at End-of-Life	0%



Estimated data for earlier years	1996	1997	1998	1999	2000	2001	2002	2003	2004	**2005**
Production	0	0	81	167	259	355	458	566	680	**800**
Agent in Exports	0	0	0	0	0	0	0	0	0	**0**
Agent in Imports	0	0	20	42	65	89	114	141	170	**200**
Total New Agent in Domestic Equipment	0	0	102	209	323	444	572	707	850	**1000**
Agent in Retired Equipment	0	0	0	0	0	0	0	0	0	**0**
Destruction of agent in retired equipment	0	0	0	0	0	0	0	0	0	**0**
Release of agent from retired equipment	0	0	0	0	0	0	0	0	0	**0**
Bank	0	0	102	296	575	933	1365	1867	2437	**3071**
Emission	0	0	15	44	86	140	205	280	365	**461**

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Initial data and parameters – example

Current Year	2005

Use in current year - 2005 (tonnes)	Data Used Here
Production of HFC-143a	800
Imports in current Year	200
Exports in current year	0
Total new agent to domestic market	*1000*

Year of Introduction of HFC-143a	1998
Growth Rate in New Equipment Sales	3.0%

Tier 1 Defaults	
Assumed Equipment Lifetime (years)	15
Emission Factor from installed base	15%
% of HFC-143a destroyed at End-of-Life	0%

Data use and results

Estimated data for earlier years	1996	1997	1998	1999	2000	2001	2002	2003	2004	**2005**
Production	0	0	81	167	259	355	458	566	680	**800**
Agent in Exports	0	0	0	0	0	0	0	0	0	**0**
Agent in Imports	0	0	20	42	65	89	114	141	170	**200**
Total New Agent in Domestic Equipment	0	0	102	209	323	444	572	707	850	**1000**
Agent in Retired Equipment	0	0	0	0	0	0	0	0	0	**0**
Destruction of agent in retired equipment	0	0	0	0	0	0	0	0	0	**0**
Release of agent from retired equipment	0	0	0	0	0	0	0	0	0	**0**
Bank	0	0	102	296	575	933	1365	1867	2437	**3071**
Emission	0	0	15	44	86	140	205	280	365	**461**

Refrigerant blends

Refrigerant blends contain a mixture of two or more refrigerants.

Examples:

HFC or blend	HFC-23	HFC-32	HFC-125	HFC-143a	HFC-134a
R-404A	0.0%	0.0%	44.0%	52.0%	4.0%
R-407C	0.0%	23.0%	25.0%	0.0%	52.0%
R-410A	0.0%	50.0%	50.0%	0.0%	0.0%
R-427A	0.0%	15.0%	25.0%	10.0%	50.0%
R-449A	0.0%	24.3%	24.7%	0.0%	25.7%
R-507C	0.0%	0.0%	50.0%	50.0%	0.0%

R-407C (HFC-32/HFC125/HFC-134a)(23/25/52%)

Reading the blend content - exercise

- **HFC** Blends of HFCs such as

  R-407C (HFC-32/HFC125/HFC-134a)(23/25/52%) and

  R-410A (HFC-32/HFC-125))(50/50%)

are replacing HCFC-22 mainly in **stationary air conditioning**.

- **HFC** blends

  R-404A (HFC-125/HFC-143a/HFC-134a) (44.0%/52.0%/4.0%) and

  R-507A (HFC-125/HFC-143a) (50/50%)

have replaced R-502 (CFC-22/CFC-115) and HCFC-22 in **commercial refrigeration**.

Calculating individual chemical kg within an HFC blend

Example:

R-410A: 50% of HFC-32 + 50% of HFC-125

If mass (R-410A) = 100 kg

mass (HFC-32) = 50% x 100 kg = 50 kg

mass (HFC-125) = 50% x 100 kg = 50 kg

Calculating individual chemical kg within an HFC blend

Exercise:

R-407C	Blend Composition Split		
	HFC-32	HFC-125	HFC-134a
	23%	25%	52%
	HFC (kg)= Total HFC Blend (kg) * HFC (% of blend)		
5,000 kg			

Calculating individual chemical kg within a HFC blend

R-407C	Blend Composition Split		
	HFC-32	HFC-125	HFC-134a
	23%	25%	52%
	HFC (kg)= Total HFC Blend (kg) * HFC (% of blend)		
5,000	1,150	1,250	2,600

Calculating kg per HFC type

	AC				Refrigeration			
	R-407C	Blend Composition Split			R-404A	Blend Composition Split		
		HFC-32	HFC-125	HFC-134a		HFC-125	HFC-143a	HFC-134a
		23%	25%	52%		44%	52%	4%
2020	2,938.0	675.7	734.5	1,527.8	30,640.0	13,481.6	15,932.8	1,225.6
2021	1,988.2	457.3	497.1	1,033.9	56,015.1	24,646.6	29,127.9	2,240.6
2022	1,627.2	374.3	406.8	846.1	76,507.1	33,663.1	39,783.7	3,060.3
2023	5,085.0	1,169.6	1,271.3	2,644.2	58,947.2	25,936.8	30,652.5	2,357.9

Calculating kg per HFC type

	AC				Refrigeration			
	R-407C	Blend Composition Split			R-404A	Blend Composition Split		
		HFC-32	HFC-125	HFC-134a		HFC-125	HFC-143a	HFC-134a
		23%	25%	52%		44%	52%	4%
2020	2,938.0				30,640.0			
2021	1,988.2				56,015.1			
2022	1,627.2				76,507.1			
2023	5,085.0				58,947.2			

Reporting requirements – general for the whole inventory

- Quality criteria: Transparency, Accuracy, Completeness, Consistency, Comparability
- Base year = 1990. Flexibility: report instead data covering, at a minimum, the reference year/period for its NDC under Article 4 of the Paris Agreement and, in addition, a consistent annual time series from at least 2020 onwards (para 57)
- The latest reporting year ≤ 2 years before the submission of the national inventory report. Flexibility: 3 years (para 58)
- Methods used; the rationale for the choice of methods; the descriptions, assumptions, references, and sources of information used for the emission factors and activity data used to compile the GHG inventory.
- Information on the category and gas, and the methodologies, emission factors, and activity data used at the most disaggregated level, to the extent possible

Reporting requirements – specific for HFCs

- Year of introduction for each gas
- Activity data: imports, exports, destruction values for each year per gas in kg (or tonnes + Net consumption calculation (in kg of tonnes of each gas)
- Assumptions (on activity data, parameters, EF, etc.)
- Information on the methodological approach used for emissions estimation (e.g., methodological tier and specific method used - tier 1a, or tier 1b, or tier 1a/b, etc.) and choice of EFs (if applicable)
- Transparent description of how the emissions were estimated (so that the 3rd Party could reproduce the estimations using the provided input AD and parameters
- Actual emissions of HFCs, PFCs, SF6, and NF3, providing disaggregated data by chemical (e.g. HFC-134a) and category in units of mass and in mass of CO2 eq.
- Uncertainties, QA/QC notes, improvement plan

Thank you!
Questions?