UNDP SIDE EVENT AT THE 29th MOP
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HFC Emissions Evaluation Using IPCC Methods

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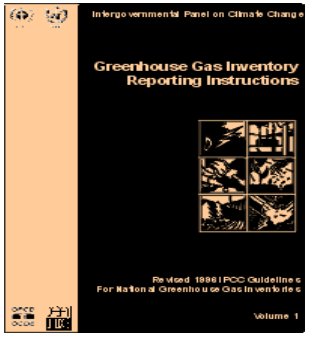
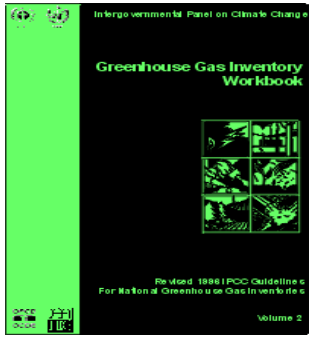
IPCC Guidelines

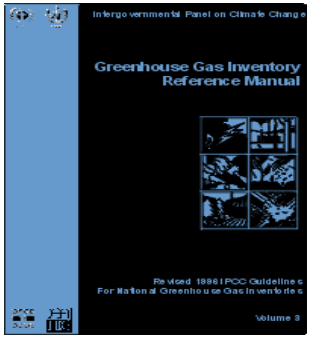
“1995” and “Revised 1996” IPCC Guidelines for National Greenhouse Gas Inventories



Volume 1 Reporting Instructions



Volume 2 Workbook + IPCC Software



Volume 3 Reference Manual

2006 IPCC Guidelines for National Greenhouse Gas Inventories

Emissions of F-gases

IPCC 2006 Guidelines: Chapter 7 “Emissions of Fluorinated Substitutes for Ozone Depleting Substances”

- **refrigeration and air conditioning;**
- fire suppression and explosion protection
- aerosols
- solvent cleaning
- foam blowing
- other applications

“2019 Refinement to the 2006 IPCC Guidelines for National GHG Inventories”

Levels of Data Aggregation

- When selecting a method for estimating emissions, it is *good practice* to consider the number and relevance of sub-applications, the data availability, and the emission patterns.
- The *potential* emission: emissions are estimated the amount of virgin chemical consumed annually in the country minus the amount of chemical destroyed or exported
- *IPCC 2006 Guidelines*, Tier 1 and Tier 2 methods: estimates of *actual* emissions rather than *potential* emissions.

Data Requirements

TABLE 7.2
OVERVIEW OF DATA REQUIREMENTS FOR DIFFERENT TIERS AND APPROACHES

	Approach A (emission-factor approach)	Approach B (mass-balance approach)
Tier 2 (emission estimation at a disaggregated level)	· **Data on chemical sales and usage pattern by sub-application [country-specific or globally/regionally derived]** · **Emission factors by sub-application [country-specific or default]**	· **Data on chemical sales by sub-application [country-specific or globally/regionally derived]** · **Data on historic and current equipment sales adjusted for import/export by sub-application [country-specific or globally/regionally derived]**
Tier 1 (emission estimation at an aggregated level)	· **Data on chemical sales by application [country-specific or globally/regionally derived]** · **Emission factors by application [country-specific or (composite) default]**	· **Data on chemical sales by application [country-specific or globally/regionally derived]** · **Data on historic and current equipment sales adjusted for import/export by application [country-specific or globally/regionally derived]**

Approaches for Emission Estimates

Determination of Refrigerant Emissions by Mass Balance

Emissions = Annual Sales of New Refrigerant
−Total Charge of New Equipment
+ Original Total Charge of Retiring Equipment −
Amount of Intentional Destruction

Tier 1

Tier 1 Refrigeration
Argentina - HFC-143a

HFC-143a

Current Year	2005

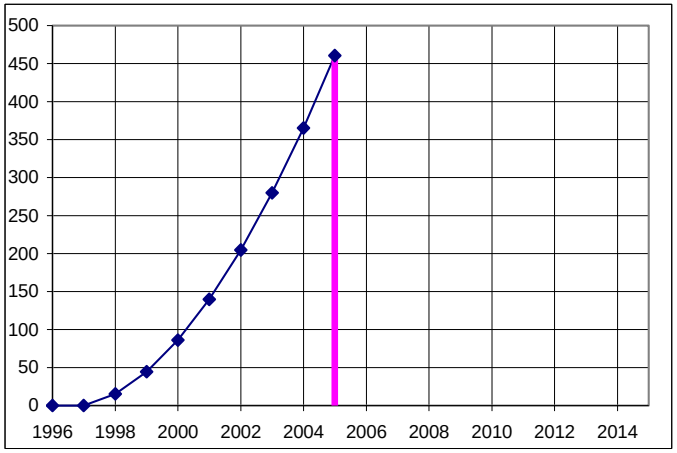
Use in current year - 2005 (tonnes)	Data Used Here
Production of HFC-143a	800
Imports in current Year	200
Exports in current year	0
Total new agent to domestic market	*1000*

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%

Summary

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



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**

Tier 2a – Emission-factor approach

$E_{containers,t}$ = emissions related to the management of refrigerant containers

$E_{charge,t}$ = emissions related to the refrigerant charge: connection and disconnection of the refrigerant container and the new equipment to be charged

$E_{lifetime,t}$ = annual emissions from the banks of refrigerants associated with the six sub-applications during operation (fugitive emissions and ruptures) and servicing

$E_{end\text{-}of\text{-}life,t}$ = emissions at system disposal

$$E_{total,t} = E_{containers,t} + E_{charge,t} + E_{lifetime,t} + E_{end\text{-}of\text{-}life,t}$$

Equations for Emission Estimates

- **Emissions from Management of Containers**

$$E_{containers,t} = RM_t \bullet c$$

- **Emissions when Charging New Equipment**

$$E_{charge,t} = M_t \bullet k / 100$$

- **Emissions During Equipment Lifetime**

$$E_{lifetime,t} = B_t \bullet x / 100$$

- **Emissions at System End-of-life**

$$E_{end\text{-}of\text{-}life,t} = Mt{-}d \bullet p/100 \bullet (1 - \eta rec,d)/100$$

Choice of Emission Factors

Tier 2a method

- *Good practice* for choosing emission factors is to use country-specific data, based on information provided by equipment manufacturers, service providers, disposal companies, and independent studies.
- When national data are unavailable, inventory compilers should use the default emission factors shown in Table 7.9,
- Estimates for Charge, Lifetime and Emission Factors, which summarises best estimates of equipment charge, lifetime, and emission factors.

Choice of emission factors

TABLE 7.9
ESTIMATES[1] FOR CHARGE, LIFETIME AND EMISSION FACTORS FOR REFRIGERATION AND AIR-CONDITIONING SYSTEMS

Sub-application	Charge (kg)	Lifetimes (years)[2]	Emission Factors (% of initial charge/year)[3]		End-of-Life Emission (%)	
Factor in Equation	**(M)**	**(d)**	**(k)**	**(x)**	**($\square_{rec,d}$)**	**(p)**
			Initial Emission	**Operation Emission**	**Recovery Efficiency[4]**	**Initial Charge Remaining**
Domestic Refrigeration	0.05 □ M □ 0.5	12 □ d □ 20	0.2 □ k □ 1	0.1 □ x □ 0.5	0 < $\square_{rec,d}$ < 70	0 < p < 80
Stand-alone Commercial Applications	0.2 □ M□ 6	10 □ d □ 15	0.5 □ k □ 3	1 □ x □ 15	0 < $\square_{rec,d}$ < 70	0 < p < 80
Medium & Large Commercial Refrigeration	50 □ M □ 2000	7 □ d □ 15	0.5 □ k □ 3	10 □ x □ 35	0 < $\square_{rec,d}$ < 70	50 < p < 100
Transport Refrigeration	3 □ M □ 8	6 □ d □ 9	0.2 □ k □ 1	15 □ x □ 50	0 < $\square_{rec,d}$ < 70	0 < p < 50
Industrial Refrigeration including Food Processing and Cold Storage	10 □ M □ 10,000	15 □ d □ 30	0.5 □ k □ 3	7 □ x □ 25	0 < $\square_{rec,d}$ < 90	50 < p < 100
Chillers	10 □ M□ 2000	15 □ d □ 30	0.2 □ k □ 1	2 □ x □ 15	0 < $\square_{rec,d}$ < 95	80 < p < 100
Residential and Commercial A/C, including Heat Pumps	0.5 □ M□ 100	10 □ d □ 20	0.2 □ k □ 1	1 □ x □ 10	0 < $\square_{rec,d}$ < 80	0 < p < 80
Mobile A/C	0.5 □ M □ 1.5	9 □ d □ 16	0.2 □ k □ 0.5	10 □ x □ 20[5]	0 < $\square_{rec,d}$ < 50	0 < p < 50

[1] Based on information contained in UNEP RTOC Reports (UNEP-RTOC, 1999; UNEP-RTOC, 2003)

[2, 3] Lower value for developed countries and higher value for developing countries

[4] The lower threshold (0%) highlights that there is no recovery in some countries.

[5] Schwarz and Harnisch (2003) estimates leakage rates of 5.3% to 10.6%; these rates apply only to second generation mobile air conditioners installed in European models in 1996 and beyond.

Thank you!

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