F-Gas Bank Inventories

Exploratory Estimates for Asian Countries Using Open Data

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Our Experience with ODS/HFC Bank Inventories

Ministry of the Environment, Japan (MOEJ)

- Prototyped ODS/HFC bank inventories, including future projections to identify the reduction potential and uncover needs for international cooperation.
- Countries:

  <2022> Maldives, Cambodia, the Philippines, Malaysia, Viet Nam

  <2023> Bangladesh, Pakistan, Sri Lanka, Lao PDR and Palau

Japan International Cooperation Agency (JICA)

- Provided technical support for improving HFC emissions inventories in Mongolia and Malaysia.

Asian Development Bank (ADB)

- Provided technical support for developing HFC bank/emissions inventories in Maldives and Vietnam.

Key Findings

Data quality control is essential

- Inconsistent or incomplete data significantly affects the reliability of ODS/HFC bank estimates
- Rigorous validation and cross-checking are necessary to ensure accuracy.

Allocation of HFC gas species is complex

- Huge data gaps exists for pre-charged refrigerants.

Large equipment types vary widely

- Industrial refrigeration and chillers exhibit diverse specifications and usage patterns.
- A targeted census or survey may be needed.

Key Findings

ODS emissions are projected to continue for another decade

- End-of-life equipment will still contain HCFC refrigerants until around 2035, requiring proper recovery, reclamation, and destruction.

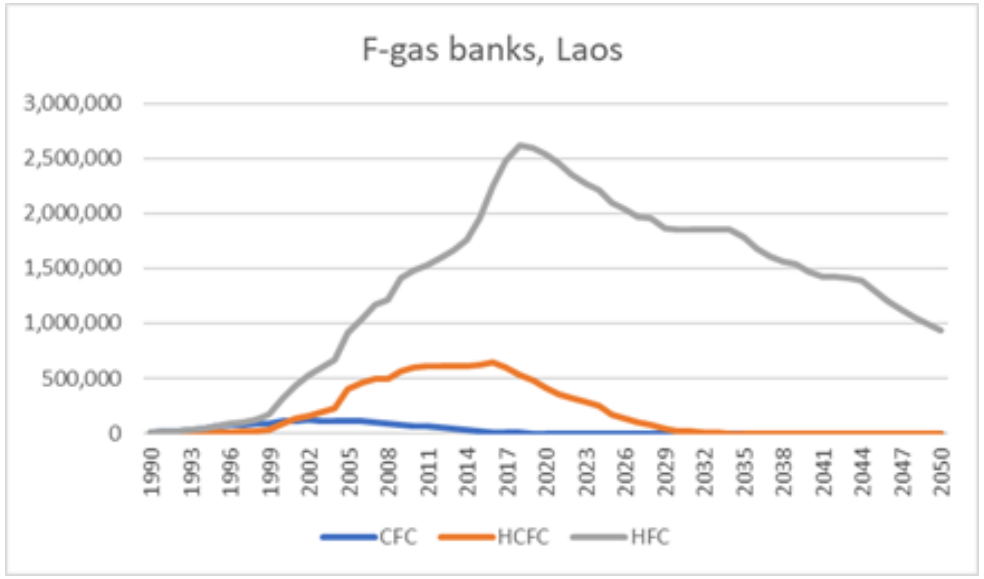
Treatment capacity needs are increasing

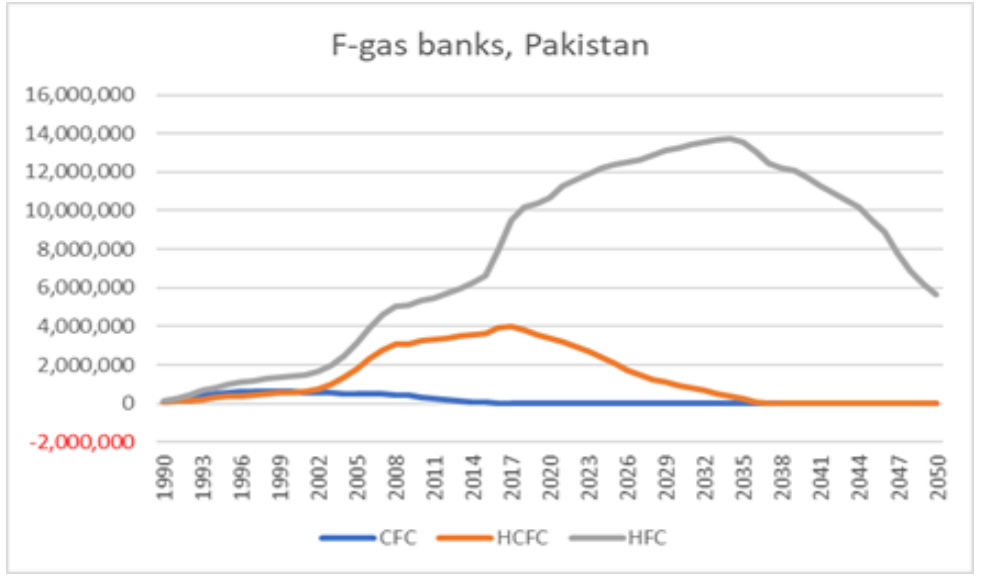
- A country with a large population is reaching a point where the annual volume of waste refrigerants will be sufficient to operate at least one cement-kiln-based destruction facility at full capacity.
  ➔ Recovery and EoL treatment are needed urgently

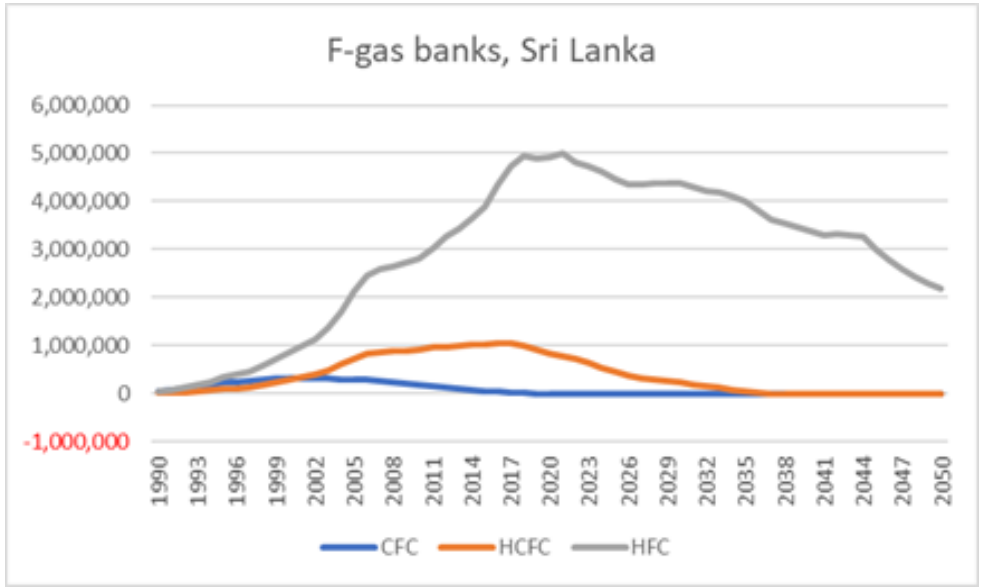
Small countries face unique risks

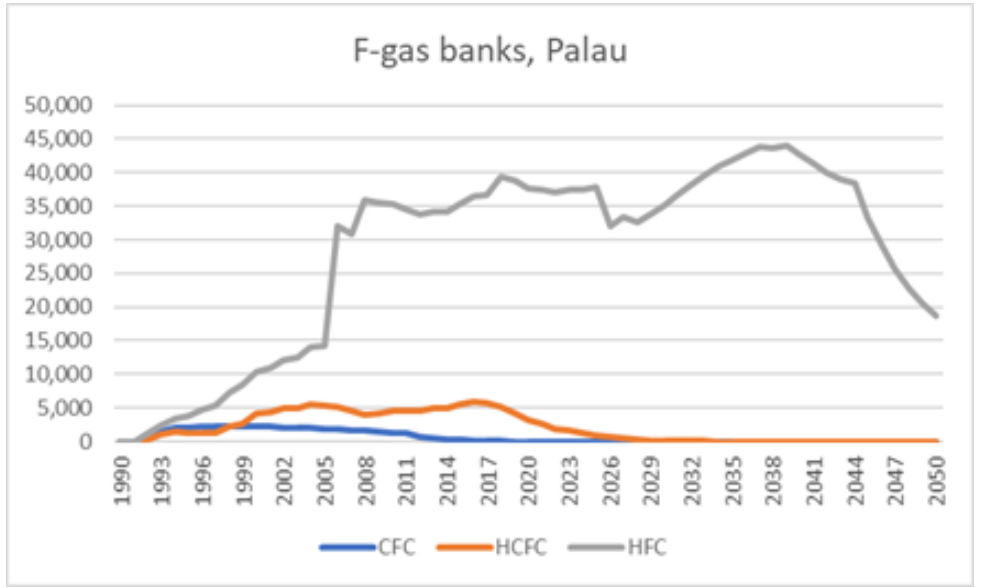
- Sudden, large-scale imports of refrigeration equipment- often due to donor programs or market shifts- can overwhelm existing recovery and treatment infrastructure, posing environmental and logistical challenges.

Some results









Bank Inventory as a foundation for BTR and NDC under the Paris Agreement

- Data is key to planning and progress-tracking life cycle refrigerant management
- Bank inventories provide a clear picture of future projections and needs.
- Strengthening coordination between Paris Agreement and Montreal Protocol/Kigali Amendment reporting processes would enhance overall consistency and efficiency.

As of 30 October 2025

Region	Number of parties*	BTR			NDC**	
		Submitted	HFC inventory included	(of refrigerant)	HFC covered	LRM included
Africa	53	21	17	17	25	5
Asia and Pacific	58	26	18	18	25	5
Europe	9	6	5	5	4	0
Latin America and Caribbean	33	18	16	15	20	5

** Only covers Non-Annex I countries* *** The latest NDC of each country*

Thank you for your attention!

Supplementary Information

Steps to Develop the F-gas Bank Inventory:

Step 1
Calculation of Net Import of Equipment

To estimate the amount of F-gas pre-charged in equipment

Step 2
Calculation of Bulk Amount of Refrigerant

To estimate the quantity of refrigerant as bulk, not pre-charged in equipment

Step 3 Calculation of Refrigerant Weight

Step 4 Allocation of Equipment by Refrigerant Type

Step 5 Calculation of ODS/HFC Banks

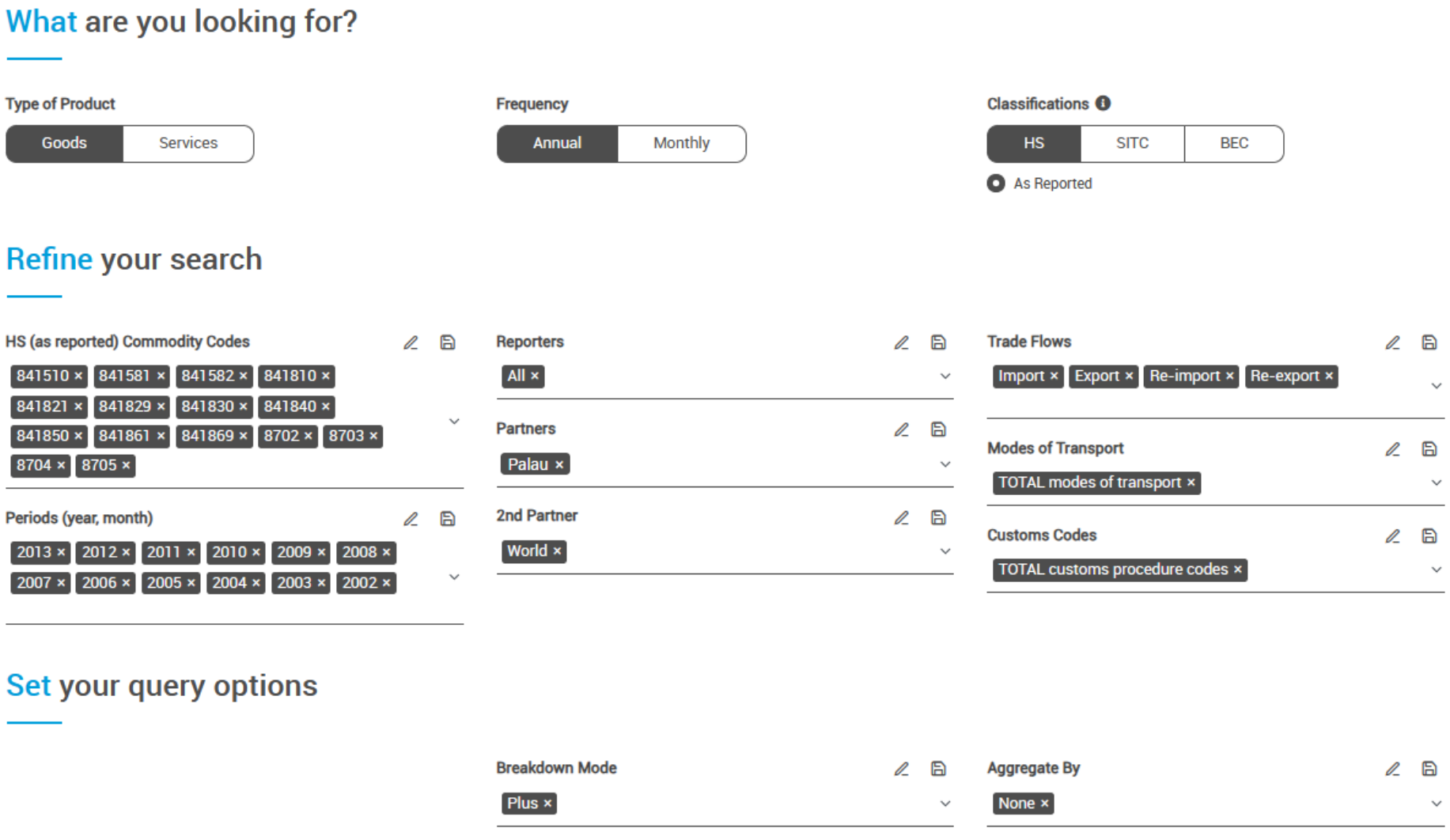
Methodologies and Resources

- Based on GIZ's methodology, with OECC's own enhancements to ensure data quality
- Desk study
- Inventory Gases: ODS (CFC and HCFC), HFC
- Inventory Coverage: 1990 -
- Resource:
  - ✓ Excel Sheet
  - ✓ UN Comtrade: https://comtradeplus.un.org/TradeFlow
  - ✓ Country Data: https://ozone.unep.org/countries
  - ✓ GIZ's "Global banks of ozone depleting substances" (2018): https://www.green-cooling-initiative.org/fileadmin/Publications/2018_Global_banks_of_ozone_depleting_substances.pdf
  - ✓ UN World Population Prospect: https://population.un.org/wpp/ etc.

STEP1- Calculation of Net Import of Equipment

Data Collection

- UN Comtrade database



STEP1- Calculation of Net Import of Equipment

Data Processing

Data downloaded from UN Comtrade database

AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AQ	AR	AT	AU
1 otDesc	QtyUnitCo	QtyUnitAb	Qty	IsQtyEstir	AltQtyUnit	AltQtyUnit	AltQty	IsAltQtyEs	NetWgt	IsNetWgtE	GrossWgt	IsGrossW	Fobvalue	PrimaryVa	IsReporte	IsAggregate
2 OTAL M	5	u	12	FALSE	-1	N/A		FALSE	5316	FALSE		FALSE	106486	106486	TRUE	FALSE
3 OTAL M	8	kg	5687	FALSE	-1	N/A		FALSE	5687	FALSE		FALSE	316379	316379	TRUE	FALSE
5 OTAL M	8	kg	1312	FALSE	-1	N/A		FALSE	1312	FALSE		FALSE	26013	26013	TRUE	FALSE
6 OTAL M	8	kg	332	FALSE	-1	N/A		FALSE	332	FALSE		FALSE	4639	4639	TRUE	FALSE
7 OTAL M	8	kg	1625	FALSE	-1	N/A		FALSE	1625	FALSE		FALSE	42517	42517	FALSE	FALSE
8 OTAL M	8	kg	511	FALSE	-1	N/A		FALSE	511	FALSE		FALSE	13250	13250	FALSE	FALSE
9 OTAL M	8	kg	1625	FALSE	-1	N/A		FALSE	1625	FALSE		FALSE	39583	39583	FALSE	FALSE
10 OTAL M	8	kg	558	FALSE	-1	N/A		FALSE	558	FALSE		FALSE	29308	29308	FALSE	FALSE
11 OTAL M	5	u	2	FALSE	-1	N/A		FALSE	208	FALSE		FALSE	1874	1874	FALSE	FALSE
12 OTAL M	5	u	12	FALSE	-1	N/A		FALSE	186	FALSE		FALSE	3343	3343	FALSE	FALSE
13 OTAL M	5	u	5	FALSE	-1	N/A		FALSE	14434	FALSE		FALSE	167496	167496	TRUE	FALSE
14 OTAL M	5	u	12	FALSE	-1	N/A		FALSE	1476	TRUE		FALSE	19512	19512	TRUE	FALSE
15 OTAL M	5	u	16	FALSE	-1	N/A		FALSE	299	TRUE		FALSE	4496	4496	TRUE	FALSE
16 OTAL M	5	u	24	TRUE	-1	N/A		FALSE	425	TRUE		FALSE	6398	6398	TRUE	FALSE
17 OTAL M	5	u	1	FALSE	-1	N/A		FALSE	284	TRUE		FALSE	4275	4275	TRUE	FALSE
18 OTAL M	5	u	3	FALSE	-1	N/A		FALSE	55	TRUE		FALSE	732	732	TRUE	FALSE
19 OTAL M	-1	N/A		FALSE	-1	N/A		FALSE	1	FALSE		FALSE	61	61	TRUE	FALSE
20 OTAL M	5	u	3	FALSE	-1	N/A		FALSE	134	FALSE		FALSE	633	633	TRUE	FALSE
21 OTAL M	5	u	4	FALSE	-1	N/A		FALSE	248	FALSE		FALSE	19102	19102	TRUE	FALSE
22 OTAL M	-1	N/A		FALSE	-1	N/A		FALSE	3919	FALSE		FALSE	176968	176968	TRUE	FALSE
23 OTAL M	-1	N/A		FALSE	-1	N/A		FALSE	428	FALSE		FALSE	31243	31243	TRUE	FALSE
24 OTAL M	-1	N/A		FALSE	-1	N/A		FALSE	3500	FALSE		FALSE	99589	99589	TRUE	FALSE
25 OTAL M	-1	N/A		FALSE	-1	N/A		FALSE	210	FALSE		FALSE	6984	6984	TRUE	FALSE
26 OTAL M	5	u	49.236	TRUE	8	kg	3000	FALSE	3000	FALSE	0	FALSE	182348.1	182348.1	TRUE	FALSE

Aggregated import data from left dataset (Prepared by OECC)

AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM
	HS Code:	841861											一台当たり重量 (kg/台)			323.4285714
	Unit						Weight (kg)									
	Import		Re-Import		Export		Import			Re-Import			Export			Import (total)
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
1993	21	0	0	0	0	0	5687	0	0	0	0	0	0	0	0	39
1994	1	0	0	0	0	0	3687	0	0	0	0	0	0	0	0	12
1995	7	0	0	0	0	0	332	0	0	0	0	0	0	0	0	8
1996	0	0	0	0	0	0	1625	0	0	0	0	0	0	0	0	5
1997	1	0	0	0	0	0	511	0	0	0	0	0	0	0	0	3
1998	1	0	0	0	0	0	1878	0	0	0	0	0	0	0	0	7
1999	1	0	0	0	0	0	558	0	0	0	0	0	0	0	0	3
2000	2	0	0	0	0	0	636	0	0	0	0	0	0	0	0	4
2001	12	0	0	0	0	0	779	0	0	0	0	0	0	0	0	14
2002	0	0	0	0	0	0	200	0	0	0	0	0	0	0	0	1
2003	17	0	0	0	0	0	400	0	0	0	0	0	0	0	0	18
2004	0	0	0	0	0	0	38092	0	0	0	0	0	0	0	0	118
2005	16	0	0	0	0	0	5864	0	0	0	0	0	0	0	0	34
2006	1	24	0	0	0	0	334	0	0	0	0	0	0	0	0	26
2007	3	0	0	0	0	0	1694	0	0	0	0	0	0	0	0	8
2008	0	0	0	0	0	0	57066	0	0	0	0	0	0	0	0	176
2009	0	0	0	0	0	0	26784	0	1	0	0	0	0	0	0	83
2010	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
2011	4	0	0	0	0	0	993	0	0	0	0	0	0	0	0	7

841861 | 841850 | 841840 | 841830 | 841829 | 841821 | 841810 | 841582 | 841581

Sorted by HS Code

STEP1- Calculation of Net Import of Equipment

Data Processing - Aggregate Annual Import Data to Calculate Net Imports

Estimation of the Number of Equipment Units in the Country

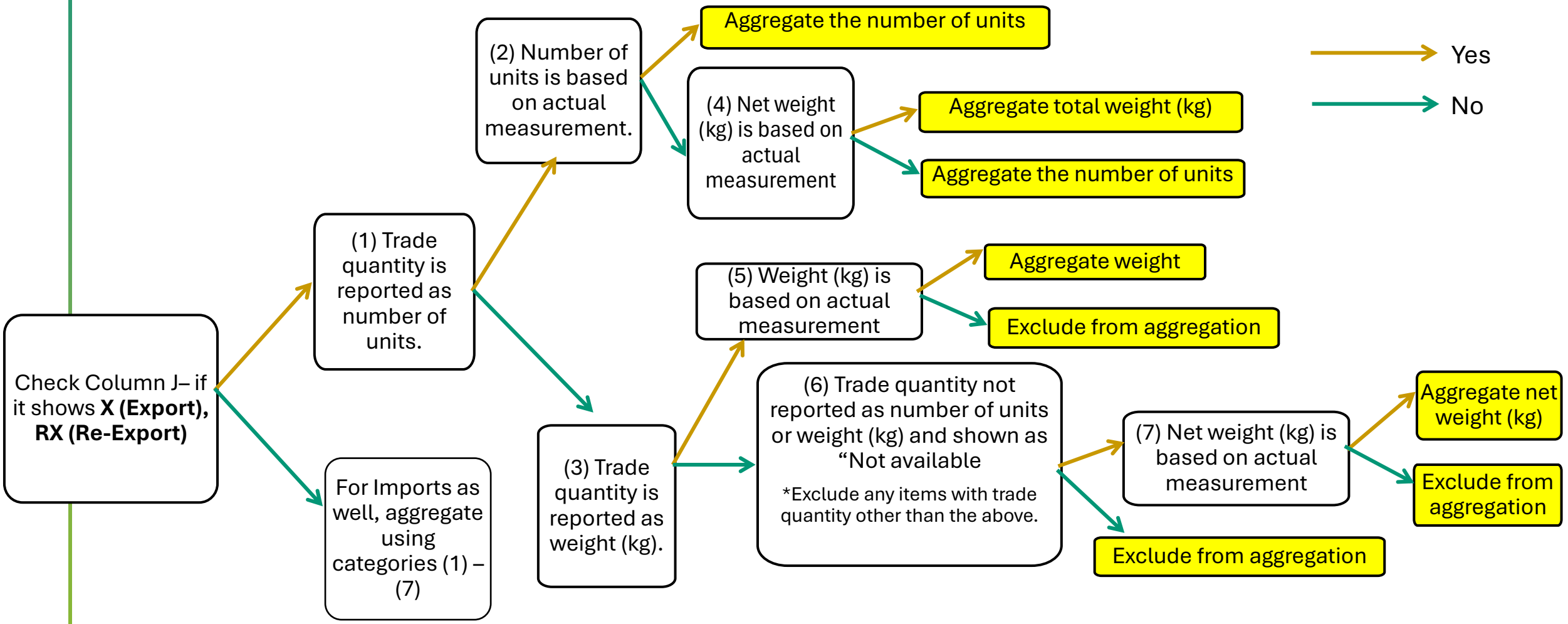
UN Comtrade database

- Import quantity reported as Trade Quantity (units or weight)
- Net weight often reported separately
- If only weight data are available, convert to units using average weight per equipment
- Proper handling of outliers (abnormal values) is needed
- For non-manufacturing countries, exports means re-exports of previously imported equipment

  ➔offset from imports

STEP1- Calculation of Net Import of Equipment

Data Processing - Decision Tree for Selecting Data for Aggregation



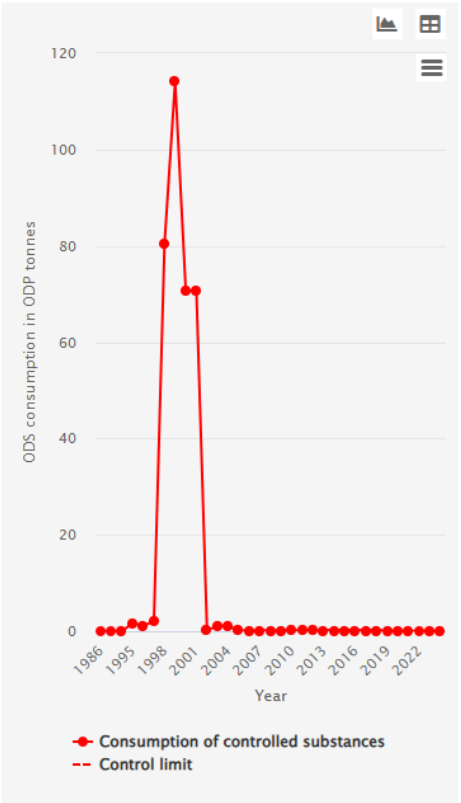
STEP2- Calculation of Bulk Amount of Refrigerant

Data Collection and Processing

- Country Data: https://ozone.unep.org/countries

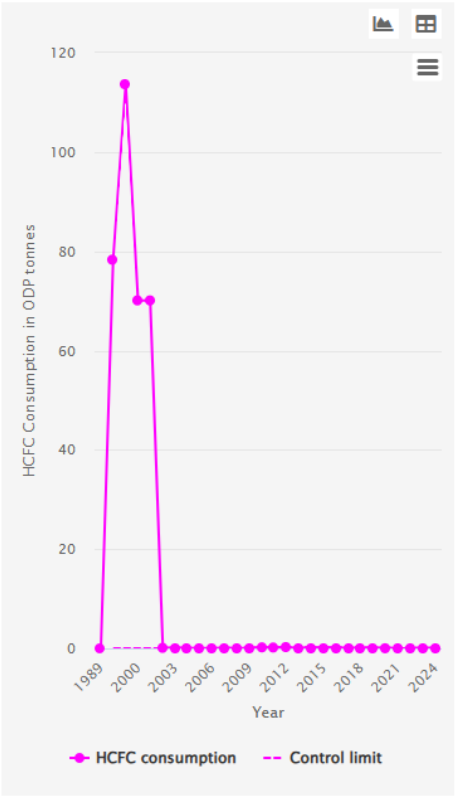
ODS consumption

'Consumption' is calculated as Production (if any) + imports - exports.



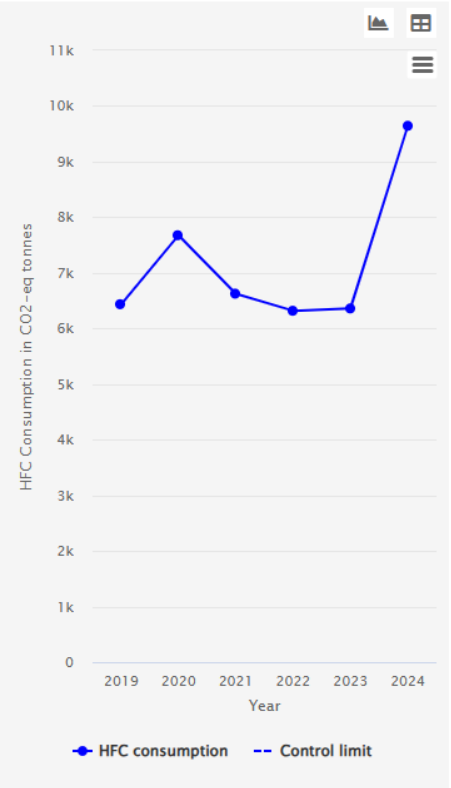
HCFC consumption

'Consumption' is calculated as production + imports – exports.



HFC consumption

'Consumption' is calculated as Production (if any) + imports - exports.



CFC = ODS consumption – HCFC consumption

STEP3- Calculation of Refrigerant Weight

Data Processing

Refrigerant Weight = Refrigerant per Unit × Net Imported Units

Average Refrigerant / Blowing Agent per Unit

Equipment / Vehicle	HS Code(s)	Refrigerant (kg/unit)	Blowing agent (kg/unit)
Air conditioners	841510, 841581, 841582	1.2	—
Refrigerators	841840, 841821, 841829, 841830, 841850, 841861	0.32	0.87
Bus	8702	4.0	—
Passenger cars	8703	0.9	—
Trucks	8704	0.6	—
Special purpose vehicles	8705	1.0	—

*Based on GIZ, “Global Banks of Ozone Depleting Substances” (2018), and OECC’s past projects

STEP4- Allocation of Equipment by Refrigerant Type

Data Processing: Sorting of Refrigerant Weight by Refrigerant Type

Refrigerant Weight by Refrigerant Type
= Refrigerant Weight (by equipment) × Ratio of Refrigerant types used in equipment

- ODS =>> non-ODS assumed as HFC replacement
- Conversions to natural refrigerants / HFOs considered negligible before 2019

Assumption of ODS Content in Pre-Charged Equipment

	Refrigerant	Blowing agent
Air-conditioners	Charge per Item: 1.2 kg (US EPA 2011)	
	Assumed gradual replacement of HCFC-22 by non-ODS[10]: ‹ 2000: 100% HCFC-22 2005: 90% HCFC-22 2010: 70% HCFC-22 2015: 50% HCFC-22 › 2017: 0% HCFC-22	
Fridges	Charge per Item: 0.32 kg refrigerant[11]	Charge per Item: 0.87 kg blowing agent[12]
	Assumed gradual replacement of CFC-12 by non-ODS: ‹ 1995: 100% CFC-12 › 2004: 0% CFC-12	Assumed gradual replacement of CFC-11 by HCFC-141b and non-ODS: ‹ 1995: 100% CFC-11 2000: 50% HCFC-141b, 50% non-ODS › 2014: 0% non-ODS

*Reference: GIZ, “Global Banks of Ozone Depleting Substances” (2018)

STEP5- Calculation of ODS/HFC Banks

Data Processing

Annual Refrigerant (ODS/HFC) Bank
= Pre-charged Imports + Bulk Consumption – Pre-charged Exports

- Palau: No domestic manufacturing ➔Bulk consumption = refrigerant servicing only

	B	C	D	E	G	H	I	J	K	L	N	O	P	Q	R	S
1	項目	Domestic Refrigerator (引用：https://www.ipcc-			Commercial refrigerator						Industrial refrigerator					
2	IPCC 2019 Refinement での記載	Domestic (i.e., household) refrigeration			Commercial refrigeration including different types of equipment, from vending machines to centralised refrigeration systems in supermarket						Industrial processes including chillers, cold storage, and industrial heat pumps used in the food,					
3	該当HSコード	841810, 841821, 841829, 841830			841840, 841850, 841861（＊841861はとりあえずCommerial とIndustrialが半々の割合であると想定）						841861（＊841861はとりあえずCommerial とIndustrialが半々の割合であると想定）					
4		CFC-12	HCFC-22	HFC-134a	CFC	HCFC-22	HFC total	HFC-134a	R-404A	R507	CFC	HCFC-22	HFC total	HFC-134a	R-404A	R507
5	比率	Assumed gradual replacement of CFC-12 by non-ODS: < 1995: 100%			Assumed gradual replacement of CFC-12 by non-ODS: < 1995:			2	6	6	Assumed gradual replacement of CFC-12 by non-ODS: <			0.3 (<1)	1	1
9	1990	1		0	1		0	0	0	0	1		0	0	0	0
10	1991	1		0	1		0	0	0	0	1		0	0	0	0
11	1992	1		0	1		0	0	0	0	1		0	0	0	0
12	1993	1		0	1		0	0	0	0	1		0	0	0	0
13	1994	1		0	1		0	0	0	0	1		0	0	0	0
14	1995	0.909090909		0.090909	0.909090909		0.090909	0.012987	0.038961	0.038961039	0.909090909		0.090909	0.011858	0.039526	0.039526
15	1996	0.818181818		0.181818	0.818181818		0.181818	0.025974	0.077922	0.077922078	0.818181818		0.181818	0.023715	0.079051	0.079051
16	1997	0.727272727		0.272727	0.727272727		0.272727	0.038961	0.116883	0.116883117	0.727272727		0.272727	0.035573	0.118577	0.118577
17	1998	0.636363636		0.363636	0.636363636		0.363636	0.051948	0.155844	0.155844156	0.636363636		0.363636	0.047431	0.158103	0.158103
18	1999	0.545454545		0.454545	0.545454545		0.454545	0.064935	0.194805	0.194805195	0.545454545		0.454545	0.059289	0.197628	0.197628
19	2000	0.454545455		0.545455	0.454545455		0.545455	0.077922	0.233766	0.233766234	0.454545455		0.545455	0.071146	0.237154	0.237154
20	2001	0.363636364		0.636364	0.363636364		0.636364	0.090909	0.272727	0.272727273	0.363636364		0.636364	0.083004	0.27668	0.27668