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**Non-CO2 Emissions Analysis:  
Expansion of AIM/Enduse[Global]**

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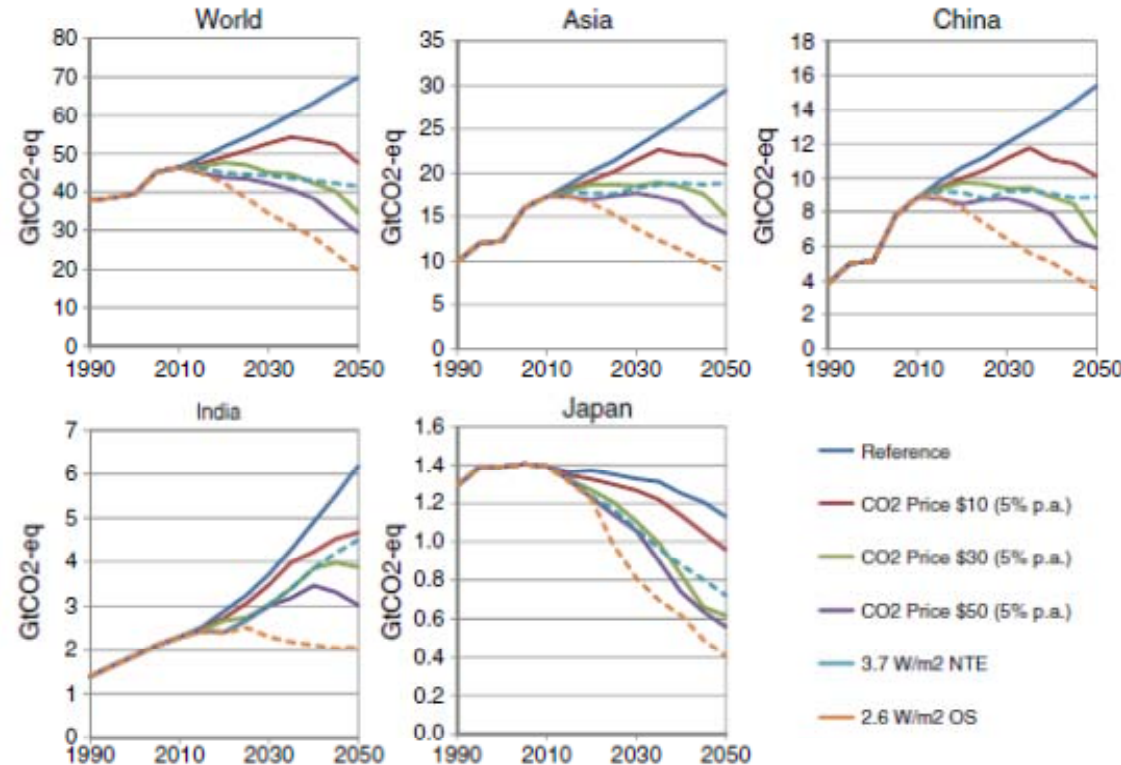
**National Institute for Environmental Studies**



- 1. Major outcomes of AIM/Enduse[Global] in FY2011-FY2012**
- 2. Remaining issues for analyzing technological feasibility of “2 degree target” and “50% reduction target”**
- 3. Fluorocarbons emissions analysis and How it important in Asia regions**

# Major Outcomes of AIM/Enduse[Global] in FY2011-FY2012

1. Technology options for meeting a 2.6W/m<sup>2</sup> target are evaluated in Asia & World.
2. **Top five key technologies are CCS, solar, wind, biomass, and biofuel** which in total account for 60% of global GHG emissions reduction in 2050.
3. If the use of CCS or biomass is limited, cumulative GHG abatement cost until 2050 increases considerably. **CCS and biomass have a vital role** in curbing mitigation costs

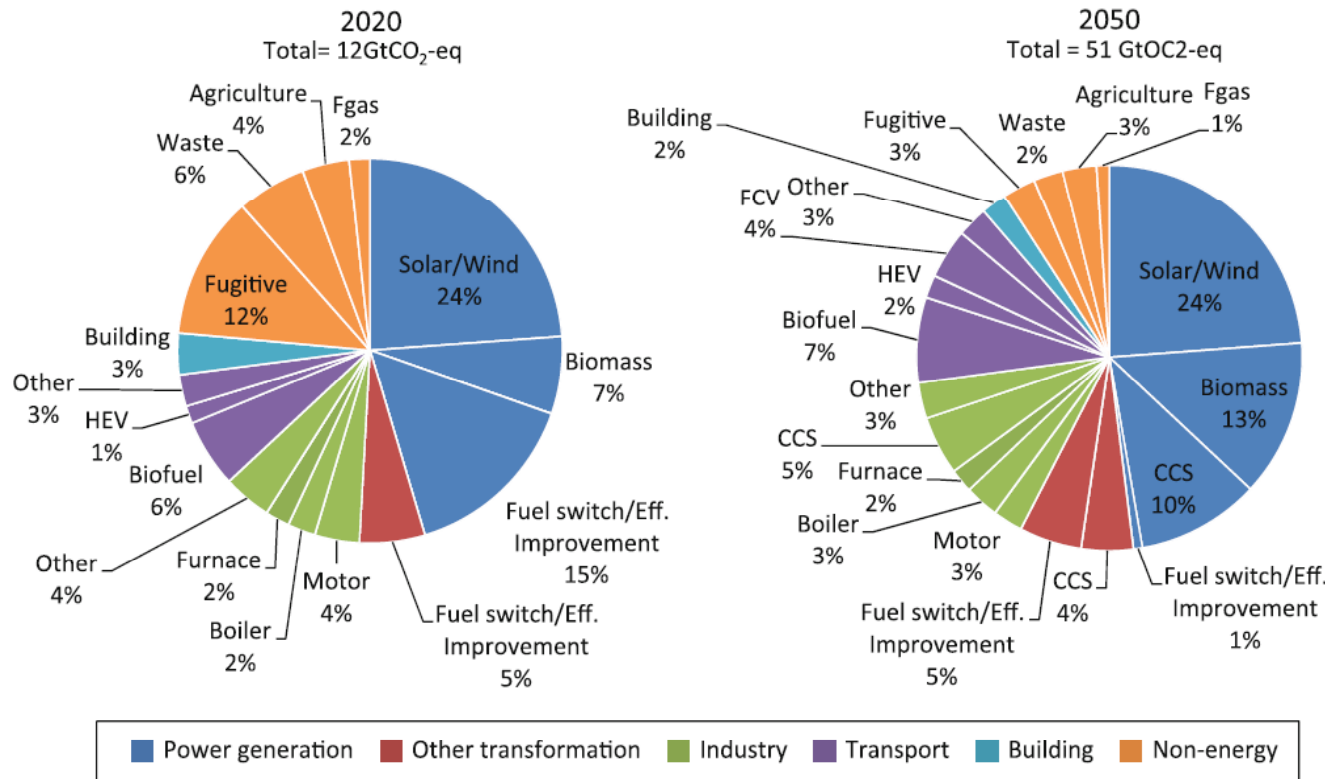


Source)

Akashi, O., Hijioka, Y., Masui, T., Hanaoka, T., and Kainuma, M. (2012) GHG emission scenarios in Asia and the world: The Key technologies for significant reduction, Energy Economics 34:s346-s358

# Major Outcomes of AIM/Enduse[Global] in FY2011-FY2012

1. Technological feasibility of achieving a 50% global GHG emission reduction target in 2050 and its transition in 2020 are evaluated.
2. MAC to achieve the target is **\$150/tCO<sub>2</sub> eq in 2020, \$600/tCO<sub>2</sub> eq in 2050.**
3. **Additional investment for achieving the target is US\$6.0 trillion by 2020 and US\$73 trillion by 2050** (corresponding to 0.7% and 1.8% of the world GDP, respectively).



Source)

Akashi, O. and Hanaoka, T. (2012) Technological feasibility and costs of achieving a 50 % reduction of global GHG emissions by 2050: mid-and long-term perspective, Sustainability Science, 7:139-156

# Remaining Issues for analyzing feasibility of 2 degree target

1. **Strengthening mitigation options in the demand-side**
  - Residential sector
  - Industry sector
2. **Updating constraints in the supply-side**
  - Potentials&costs of renewables (biomass)
  - Tracking power plants data based on LPS
3. **Reassembling datasets in non-energy & non-CO2 sectors**
  - Fluorocarbons sector, including Non-Kyoto Gas (i.e. CFCs, HCFCs)
  - CH4 emissions in waste sector
4. **Co-benefits of reducing global non-CO2 emissions (SO2, NOx, etc)**
5. Discussions on service demands and their transitions
6. Updating AIM/Enduse itself and improving interface
7. Strengthening linkage with CGE[Global]


Today's Topic

	Gas	ODP	GWP(SAR)	GWP(AR4)	Major sectors
CFC	CFC-11	1.0	4000	4750	Closed/Open foam, Aerosols, etc
	CFC-12	1.0	8500	10900	Refrigerant (automobile air-conditioning, refrigeration etc)
	CFC-113	0.8	5000	6130	Solvent (Electronic component, dry-cleaning etc)
	CFC-114	0.8	9300	10000	Open foam
HCFC	HCFC-22	0.055	1700	1810	Refrigerant (room air-conditioning, commercial refrigeration etc)
	HCFC-141b	0.11	630	725	Closed foam, Open foam, Solvent(Electronic component), etc
	HCFC-142b	0.065	2000	2310	Open foam
HFC	HFC-23	0	11700	14800	By-product of HCFC-22 production
	HFC-134a	0	1300	1430	Refrigerant, Closed/Open foam, Aerosols,
	HFC-152a	0	140	124	Aerosols, Closed foam
	HFC-32	0	650	675	Mixed refrigerants
	HFC-125	0	2800	3500	Mixed refrigerants
	HFC-143a	0	3800	4470	Mixed refrigerants
	HFC-227ea	0	2900	3220	Aerosols, Fire Extinguishers
PFC	CF4	0	6500	7390	AL production, Semiconductor Manufacturing, etc
	C2F6	0	9200	12200	AL production, Semiconductor Manufacturing, etc
SF6	SF6	0	23900	22800	Semiconductor Manufacturing, Electric Utilities, etc

**Note1) GWP values in IPCC SAR (Climate Change 1995) are used for GHGs national inventory reports under UNFCCC, because of the stipulation in the Kyoto Protocol**

**Note2) GWP values in IPCC AR4 (Climate Change 2007) are the latest and will be used for GHGs national inventory under UNFCCC, after 2015 (i.e. when we report emissions in 2013).**

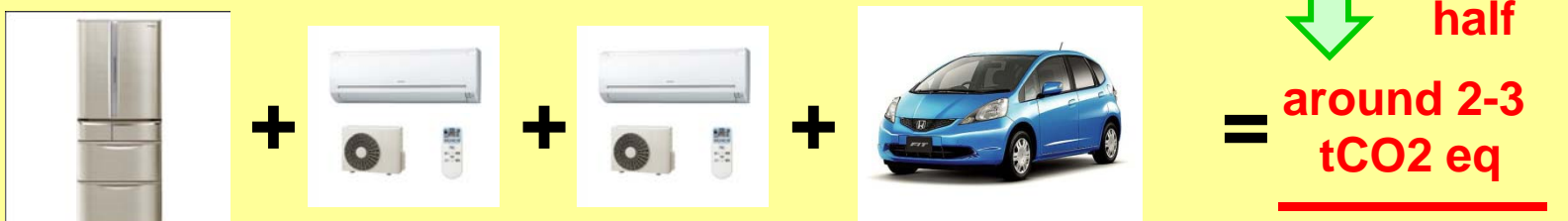
CO2 emissions per person in 2010 in Japan = 9.31 tCO2



Similar  
= around 8~9 tCO2 eq

1 room air-conditioner is hermetically sealed around 800 g of HCFC-22 refrigerant  
= around 1.4 t-CO2 eq (if it is released to the atmosphere at the time of disposal)

CO2 emissions per household in 2010 in Japan = 4.76 tCO2



Around half  
= around 2-3 tCO2 eq

1 refrigerator around 150 g of HFC-134a refrigerant = around 0.2 t-CO2 eq  
+ 2 room air-conditioner around 800 g of HCFC-22 refrigerant = around 1.4 t-CO2 eq  
+ 1 car air-conditioner around 500-700 g of HFC-134a = around 1.1 t-CO2 eq  
(if they are released to the atmosphere at the time of disposal)



# Background information: International Regimes and Issues

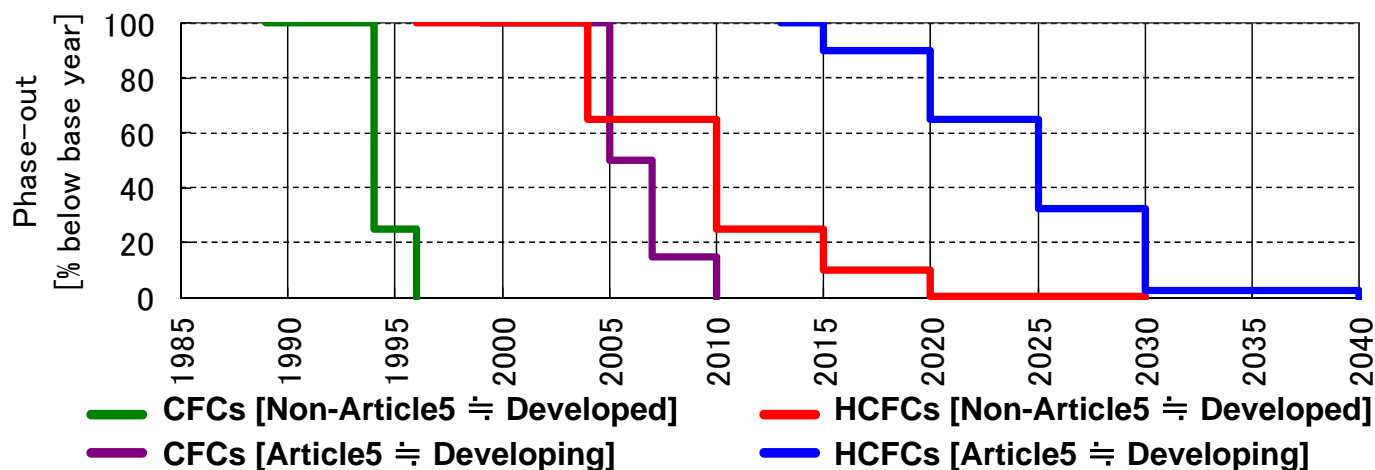
## Issue1) Insufficient linkage between the Kyoto Protocol and the Montreal Protocol

Protocol	Regulation	Target gas	Greenhouse Gas (GHG)	Ozone Depleting Substances (ODS)
KYOTO	Emissions	CO <sub>2</sub> , CH <sub>4</sub> , H <sub>2</sub> O, HFCs, PFCs, SF <sub>6</sub>	Yes	No
MONTREAL	Productions Consumptions	CFCs, HCFCs, Halons, Carbon tetrachloride, 1,1,1-trichloroethane, Methyl bromide	Yes	Yes

- ODSs are also GHGs, but no international regulation on ODS emissions.
- They have been emitted without measures, in developed/developing countries

**Q1** How large emissions in CO<sub>2</sub>?

## Issue 2) Phase-out schedule of production and consumption under the Montreal Protocol



- CFCs was abolished, but banked CFCs will be released at the time of disposal.
- HCFCs is not yet regulated in developing countries and produced large amounts

**Q2** Phase-out is far from enough?



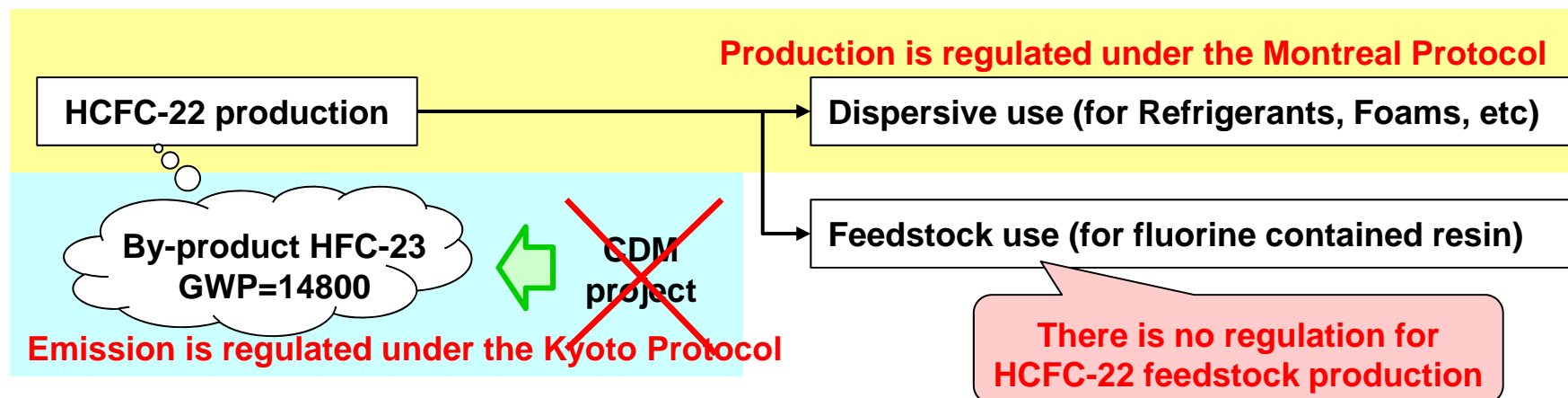
## Issue3) Limitations of financial/technological mechanism under the Montreal Protocol

- ✓ Montreal **Multilateral Fund only support measures for achieving phase-out schedule of production and consumption.** There is no fund to support measures for emissions reductions.
- ✓ Recovered fluorocarbons (e.g. refrigerants) are treated as chemical waste, **thus it will be forbidden to take out the country because of the Basel Convention.**

- Developing countries must treat recovered fluorocarbon in own countries.
- But, there is no fund, no technology and no system for recovery and treatment

Q3 **How much fund & cost?**

## Issue 4) Limitations of financial/technological mechanism under the Kyoto Protocol



- More HCFC-22 feedstock is produced, more by-product HFC-23 is emitted.
- CDM project of HFC-23 destroy is hardly accepted due to various reasons.

Q4 **How large HFC23 emission?**

## Issue5) Lack of accuracy and lack of detailed data in fluorocarbon inventory

- ✓ **Lack of accuracy of data** (e.g. incomplete data and outlier in UNEP database)
- ✓ **Inconsistency of units between different database** (e.g. in ODP ton, metric ton, and CO2 ton)
- ✓ **Lack of detailed data by gas and by category** (e.g. aggregated all gases in UNEP database)
- ✓ **Lack of data of major countries** (e.g. China, India, Russia in AFEAS database)
- ✓ **Suspected data** (e.g. inconsistency b/w emission factor and emissions in UNFCCC database)

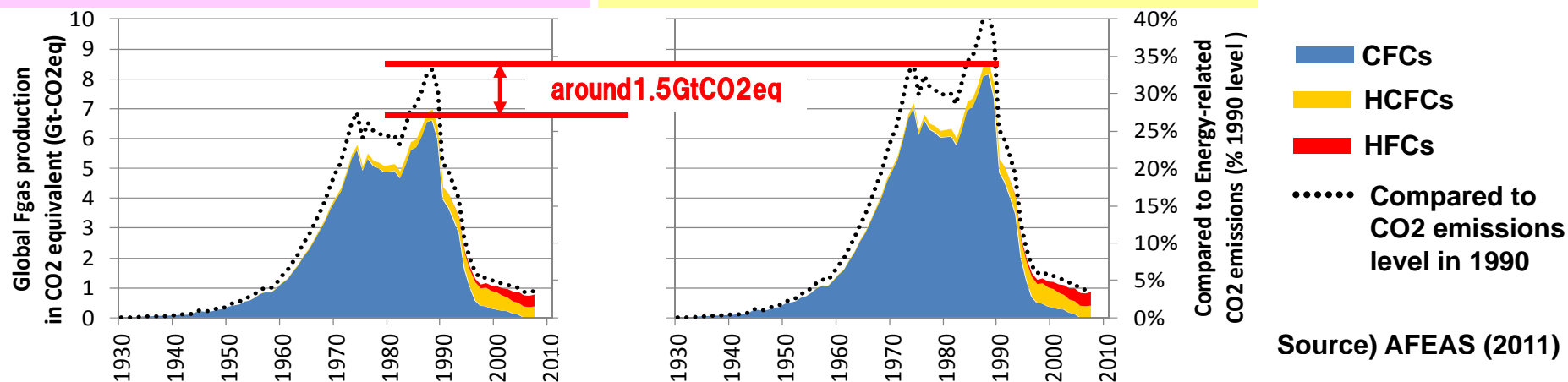
- It is necessary to create reliable global inventory from scratch.
- Detailed data by gas & category are necessary to convert inconsistent units.

Q5 **How accurate and detail?**

## Issue6) Large effects caused by difference of Global Warming Potentials

Based on GWP values in IPCC1995  
(used for UNFCCC national report currently)

Based on GWP values in IPCC2007  
(will use for UNFCCC national report after 2015)

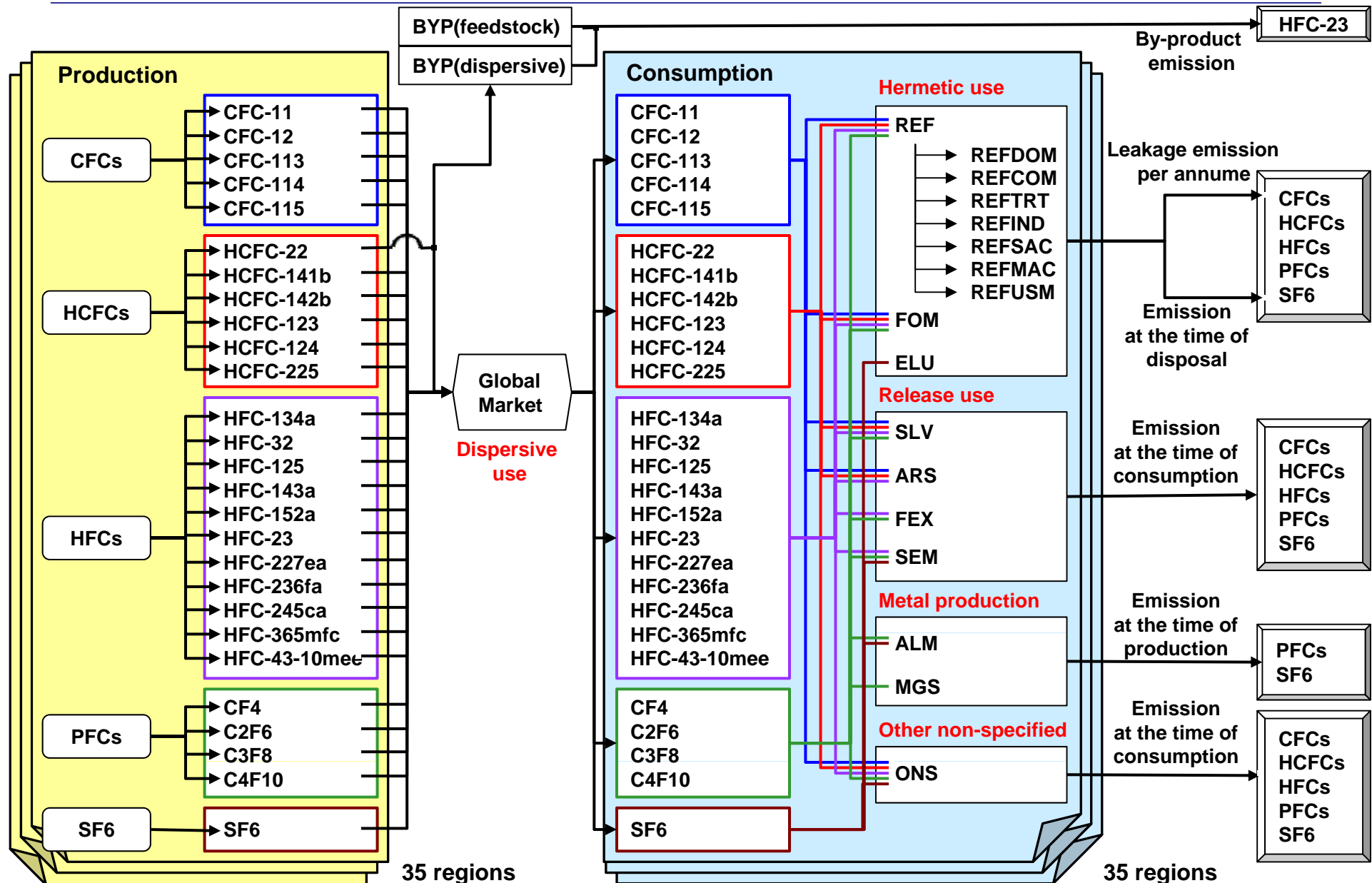


**Note) AFEAS database is used for representing global fluorocarbon production, however the database is missing some major developing countries (e.g. China, India, Russia). Thus, this figure shows underestimated values. (e.g. CFCs production in 2004 represents 16 % of global production reported in UNEP).**

# Target Sectors and Gases

Code	Category	GHG	Mitigation option
BYP	By-production emission	HFC	Thermal oxidation
REF	Refrigerants	CFC, HCFC, HFC, PFC	Alternative refrigerants (carbon dioxide, hydrocarbons, NH <sub>3</sub> , etc), Leakage reduction, Recovery, Decomposition
ARS	Aerosols	CFC, HCFC, HFC	Alternative aerosol (hydrocarbon aerosol propellants, not-in-kind alternatives), 50% reduction (for medical applications, general aerosol propellants)
FOM	Foams	CFC, HCFC, HFC, PFC	Recovery, Decomposition, Alternative foams (water-blown CO <sub>2</sub> systems, liquid CO <sub>2</sub> foam blowing, hydrocarbon foam blowing)
SLV	Solvents	CFC, HCFC, HFC, PFC	Alternative solvents (NIK aqueous, NIK semi-aqueous), Retrofit options, 50% reduction
FEX	Fire Extinguishers	HFC, PFC	Inert gas systems, Water mist, Leakage reduction & recovery
SEM	Semiconductor Manufacture	HFC, PFC, SF <sub>6</sub>	Cleaning facility (NF <sub>3</sub> in situ clean, NF <sub>3</sub> remote clean), Recapture/destroy, Plasma abatement, Catalytic destruction, Thermal oxidation
ALM	Aluminium Production	PFCs, SF <sub>6</sub>	Retrofit (PFPB, SWPB, CWPB, VSS, HSS)
MGS	Magnesium Foundries	SF <sub>6</sub>	SO <sub>2</sub> replacement, Recovery and recycling, Alternative fluorinated compounds
ELU	Electrical Equipment	SF <sub>6</sub>	Leak detection, Device recovery & recycling

# Overview of Global Fluorocarbon Modeling



# The latest Inventory & Baseline Emissions Scenarios

## 1. Creation of the latest global inventory by gas, by category and by country

- UNEP Ozone Secretariat database
- AFEAS database
- UNFCCC National Inventory reports in all Annex I countries
- Various national statistics/report (Japan, EU, China, Russia, Indonesia, etc)
- Journal Papers (McCulloch 1998, 2003, 2006, 2007, Miller 2010, etc)

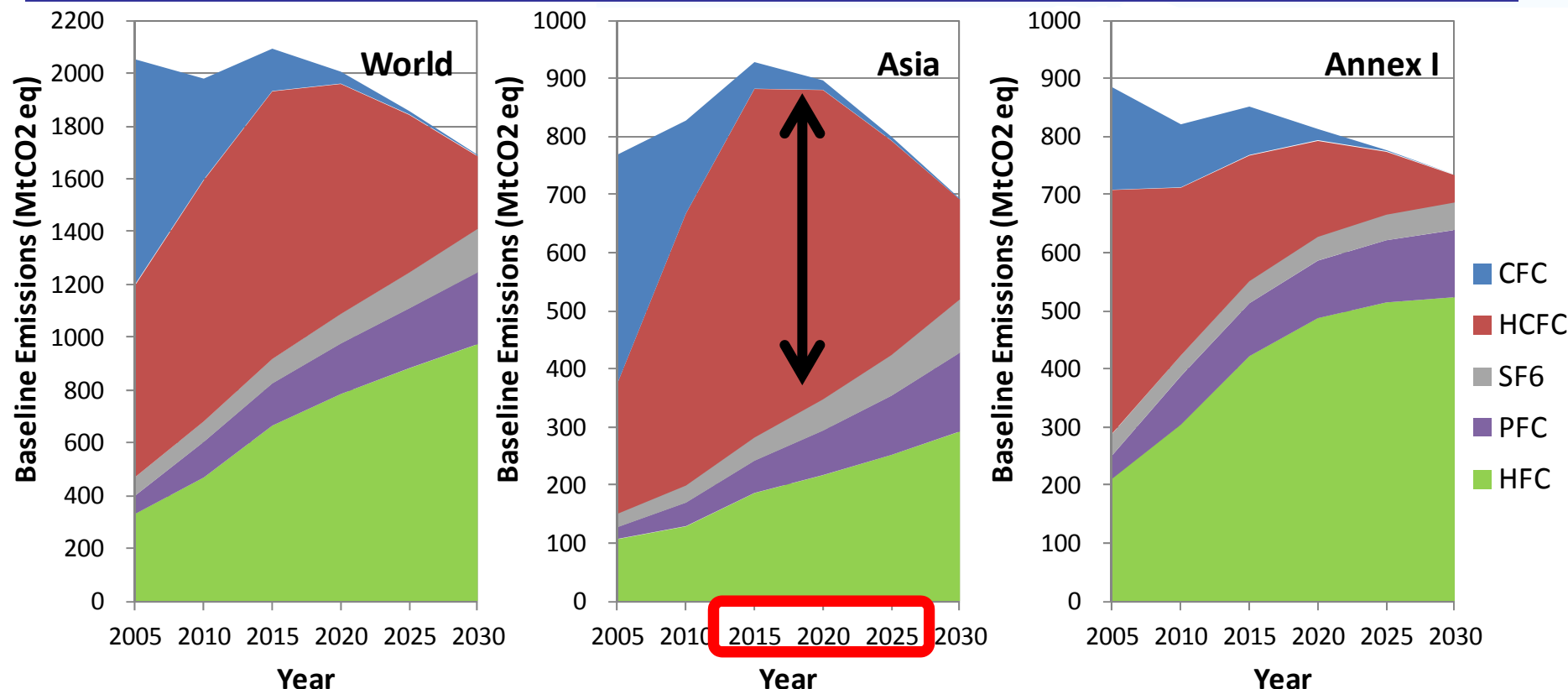
## 2. Baseline consumption scenario

- CFCs, HCFCs : Following phase-out schedule under the Montreal Protocol
- HFCs : Alternatives of CFCs and HCFCs considering phase-out (extrapolating data by sector, based on GDP&POP growth)
- PFCs, SF6 : BaU (extrapolating based on GDP & POP growth)

## 3. Baseline emission functions

- Emissions functions are determined by **considering the time delays between consumption and emissions** depending on different service types in each category (e.g. refrigerants, aerosols, foams, solvents, others)
- **Leakage of banked refrigerants during the use of appliances is considered**
- HFC-23 emission ratio (by-product of HCFC-22 production) is considered both in dispersive use and feedstock use.

# Baseline Fluorocarbon Emissions HFCs & PFCs & SF6 + CFCs & HCFCs



Note) This is still tentative result under the updating process of global fluorocarbon inventory

- ❑ Emissions of CFCs & HCFCs are larger than those of fluorinated gases under the the Kyoto GHGs in the mid-term (up to 2030), even if the world regions follow the phase-out schedule of production/consumption under the Montreal Protocol.
- ❑ It is important to consider early mitigation actions in Asia in the next 10 -20 years

It should be focused on when discussing the mid-term targets in the international regimes.

A world map showing the continents of North America, South America, Europe, Africa, Asia, and Australia. The map is rendered in a light blue color against a darker blue background. The text "Thank You" is centered over the map in a bold, dark blue font.

**Thank You**