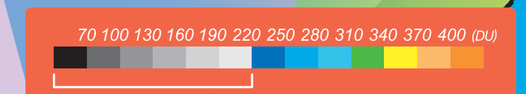

Ozone hole

The illustration on the cover shows the distribution of ozone above the Antarctic in October 2018 (the monthly average in Dobson Unit) based on the data of the Japan Meteorological Agency.

Ozone hole
2018.10

Let's protect the ozone layer

2019 edition

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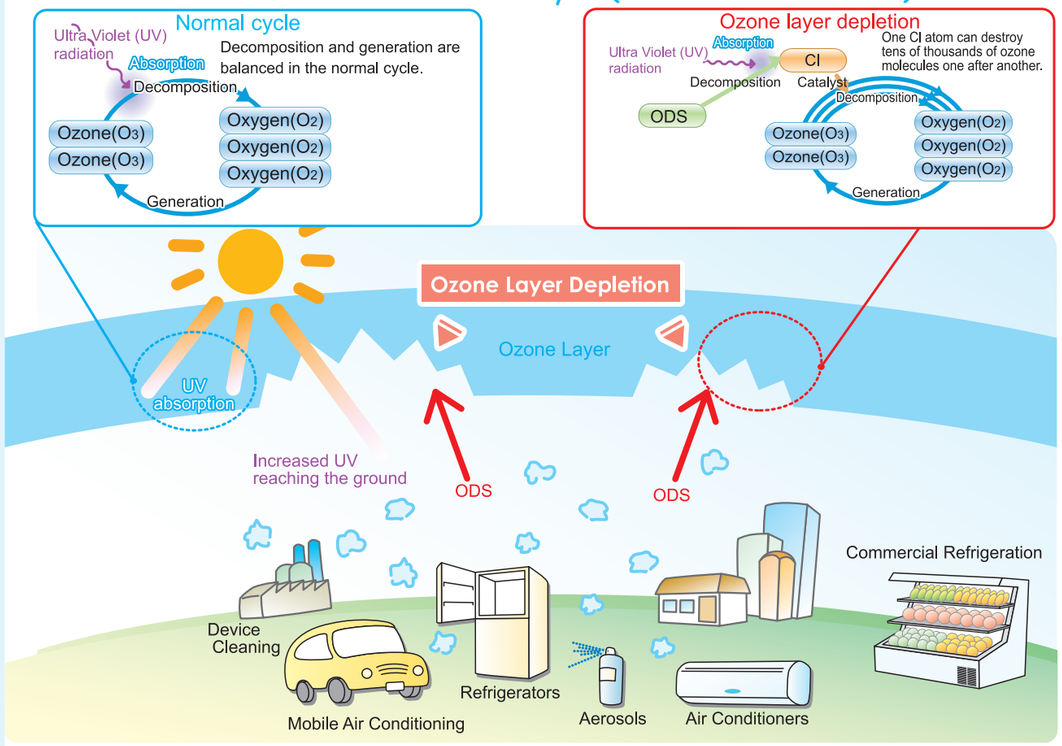
Ministry of the Environment
JAPAN

Ozone Layer & Ozone Holes

The ozone layer is a protective shield up in the air that absorbs harmful ultraviolet rays (UV-B), which can cause various negative impacts on human health and ecosystems. However, it has been destroyed by man-made chemicals called Ozone Depleting Substances (ODS) so much that there is a "hole" in the ozone layer (known as ozone hole).



Negative impacts of excessive UB on human health

Acute (symptoms immediately appear)

Sunburn
Red inflammation of the skin that appears a few hours after UV exposure

Suntan
Browning of the skin that appears a few days after UV exposure

Snow blindness
Inflammation of the iris of the eye that occurs when the eye is exposed to UV in places such as skiing grounds and marine beaches. The white of the eye congests, accompanied by pain. The symptom is remedied in 1-2 days.

Suppressions of the immune system

Chronic (symptoms gradually appear)

Skin
- Wrinkle, Freckle, Senile plaque
- Benign tumor
- Precancerous lesion
- Solar keratosis
- Skin cancer

Eye

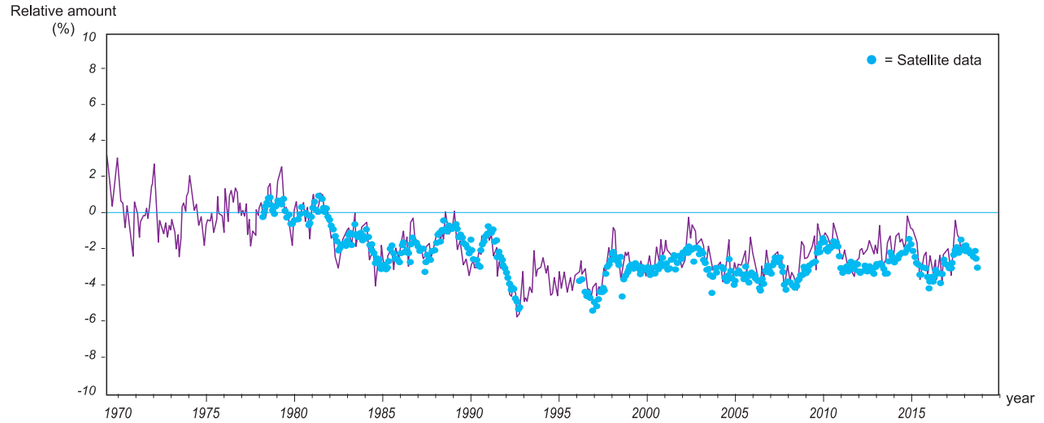
Cataract
A disease caused by UV exposure, etc. in which the crystalline lens of the eye gradually gets cloudy. The vision weakened by cataracts cannot be corrected with glasses and severe cases need surgical operation.

Pterygium
A disease in which the abnormal growth caused by UV in the tissue of the white (conjunctiva) of the eye gradually develops towards the iris (cornea). It can be removed by surgical operations but may recur.

Ozone Depleting Is Still Ongoing

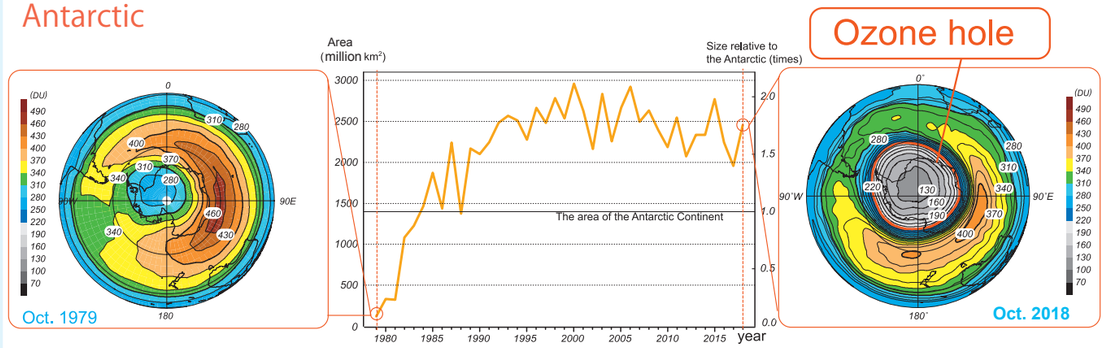
The amount of the ozone in the ozone layer decreased in the 1980s and the early 1990s. Although it picked up slightly in the recent years, the amount of ozone in the ozone layer continues to be smaller than before.

Global



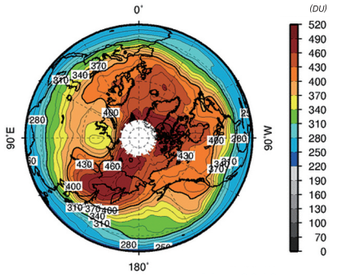
Time series in global mean total ozone
Source: Japan Meteorological Agency

Antarctic



Changes in annual maximum of the ozone hole area (center) and the total ozone maps over the Antarctic region in October (left and right)
Based on the data provided by Japan Meteorological Agency

Arctic



The depletion of the ozone layer is the severest above the Antarctic, where the ozone volume decreases drastically from August to December every year. This is called "ozone hole".
In addition, a group of scientists found the ozone depletion of a comparatively large scale above the Arctic from the winter to the spring of 2017. In 2018, the large scale of ozone depleting did not observe above this area.

Source: National Institute for Environmental Studies of Japan

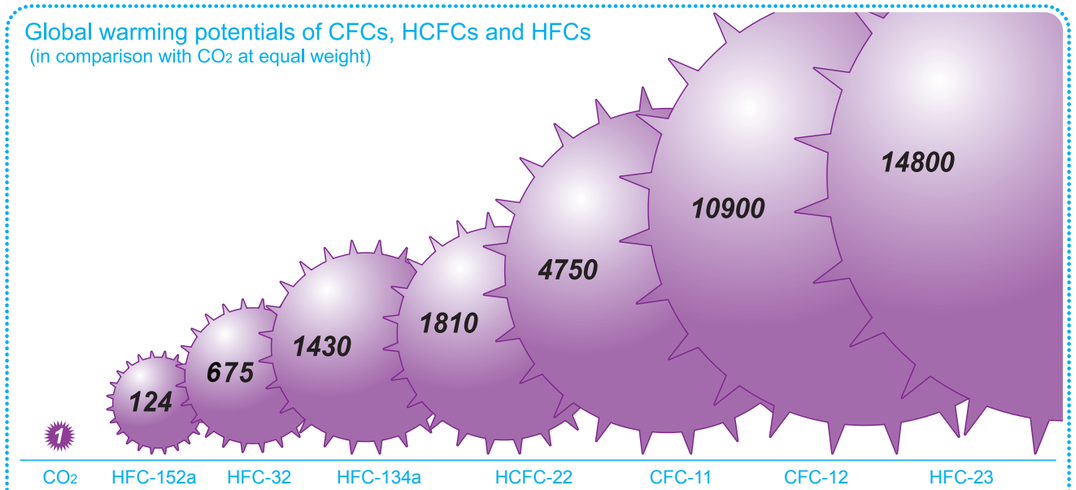
Ozone Depleting Substances & Climate Change

Ozone depleting substances (ODS) such as CFCs and HCFCs are also greenhouse gases.
Therefore, the phase-out of ODS under the Montreal Protocol has contributed and will continue to contribute to the mitigation of climate change.

In addition, HFCs that are ozone friendly and therefore used as alternatives to CFCs and HCFCs are also greenhouse gases.

CFCs, HCFCs, and HFCs are still used in our daily life. Therefore, it is important to control the emissions into the atmosphere for the prevention of climate change.

Global warming potentials of CFCs, HCFCs and HFCs
(in comparison with CO_2 at equal weight)



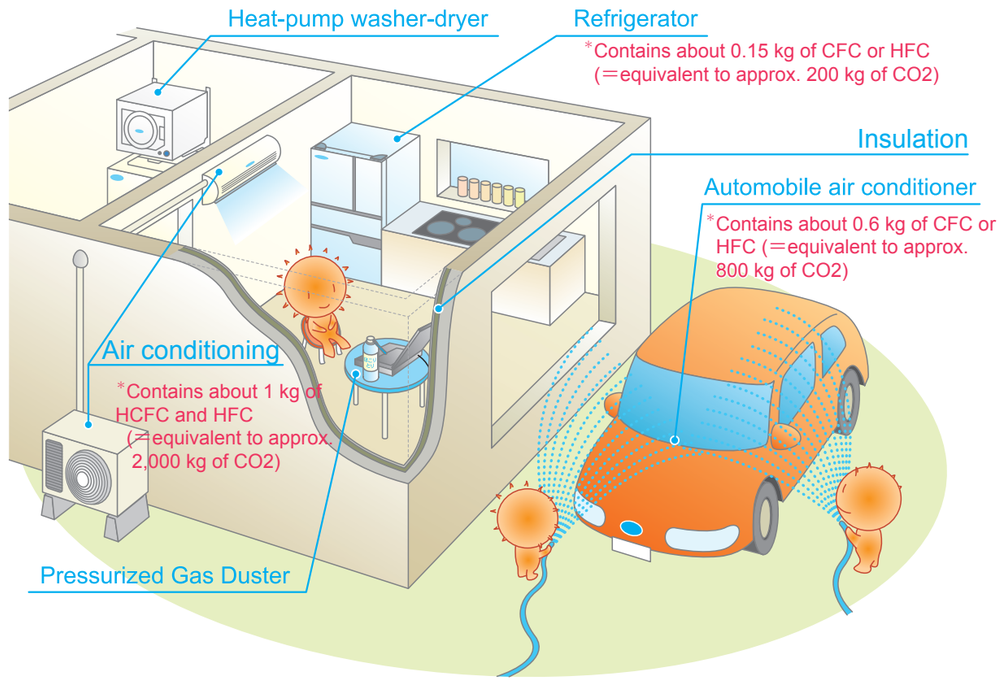
Figures have been taken from IPCC fourth assessment report (2007)

	Type	Ozone Depleting Potential	Global Warming Potential	Use
Ozone depleting substances	CFC	CFC-11 (1.0) CFC-12 (1.0) CFC-113 (0.8)	CFC-11 (4,750) CFC-12 (10,900) CFC-113 (6,130)	Refrigerants Foam blowing agents Device cleansings Aerosols
	Halon	Halon-1211 (3.0) Halon-1301 (10.0) Halon-2402 (6)	Halon-1211 (1,890) Halon-1301 (7,140) Halon-2402 (1,640)	Fire extinguishings
	Carbon Tetrachloride	1.1	1,400	Solvent used in laboratories and as materials
	1,1,1 - Trichloroethane	0.1	-	Cleaning Agents
	HCFC	HCFC-22 (0.055) HCFC-141b (0.11)	HCFC-22 (1,810) HCFC-141b (725)	Refrigerants Foaming agents Cleaning agents
	HBFC	0.74	-	(Fire extinguishings)*
	Bromochloromethane	0.12	-	(Solvents Agrichemicals Medicine Mothball)*
	Methyl Bromide	0.6	-	Soil fumigation agents (Sterilizations) Pesticide
Other fluorinated gases	HFC	0	HFC-23 (14,800) HFC-32 (675) HFC-134a (1,430) HFC-152a (124) R-410A (2,090)	Refrigerants Foaming agents Cleaning agents Aerosols
	PFC	0	7,390 -- 12,200	Solvents Device cleansing agents Semiconductor production Liquid crystal production
	SF_6	0	22,800	Electric insulator (insulating/internal) Semiconductor production Liquid crystal production Magnesium production
	NF_3	0	17,200	Solvents

* HBFC and Bromochloromethanes are not used in Japan.

Source (GWP) : IPCC fourth assessment report (2007)

CFCs, HCFCs, and HFCs are used in our daily life for...



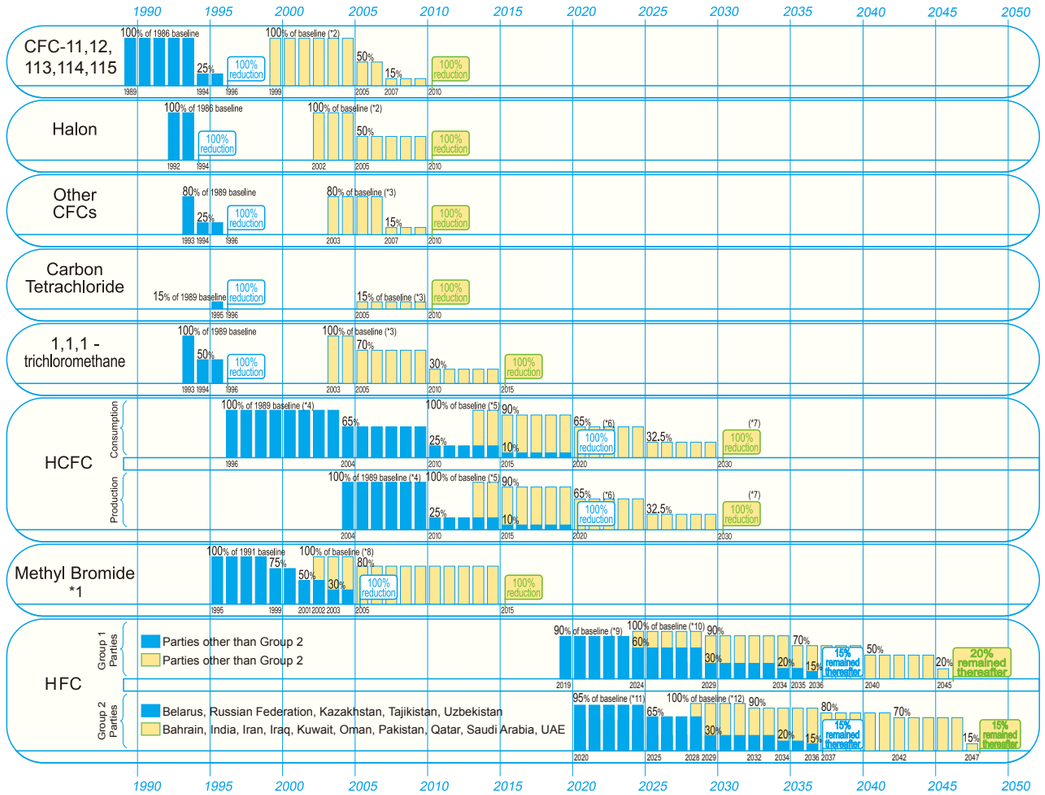
Global Efforts & Japan's Commitment

The global community has agreed to phase out ozone-depleting substances such as CFCs and HCFCs under the Montreal Protocol on Substances that Deplete the Ozone Layer (1987).

In 2016 the Parties adopted the Kigali Amendment to phase down HFCs in order to reduce the use of high global warming potential HFCs, and the Kigali Amendment entered into force in January 2019.

Japan accepted the Kigali Amendment on 18 December 2018.

ODS phase-out and HFC phase-down schedule under the Montreal Protocol



Production and consumption (= production + import - export) are to be phased out by substance group according to specific schedules.

*1) Methyl bromide used for guarantine and pre-shipment is exempted from control.
*2) Baseline = the average of production and consumption from 1995 to 1997 or 0.3 kg per capita, whichever is lower.
*3) Baseline = the average of production and consumption from 1998 to 2000 or 0.2 kg per capita, whichever is lower.
*4) Consumption baseline = HCFC consumption in 1989 + CFC consumption in 1989 x 2.8 %
Production baseline = the average of HCFC production and consumption in 1989 + the average of CFC production and consumption of 1989 x 2.8%
*5) Baseline = the average of production or consumption of 2009 and 2010.
*6) Production and consumption only for servicing of existing refrigeration and air-conditioning equipment are allowed until 2030, provided that such
production and consumption do not exceed 0.5 % of the baseline.
*7) Production and consumption only for servicing of existing refrigeration and air-conditioning equipment are allowed until 2040, provided that such
production and consumption do not exceed 2.5 % of the baseline.
*8) Baseline for methyl bromide = the average of production and consumption from 1995 to 1998.
*9) Baseline = the average of HFC production and consumption from 2011 to 2013 + the baseline of HCFC production and consumption x 15% (CO_2 eq.)
*10) Baseline = the average of HFC production and consumption from 2020 to 2022 + the baseline of HCFC production and consumption x 65%(CO_2 eq.)
*11) Baseline = the average of HFC production and consumption from 2011 to 2013 + the baseline of HCFC production and consumption x 25% (CO_2 eq.)
*12) Baseline = the average of HFC production and consumption from 2024 to 2026 + the baseline of HCFC production and consumption x 65% (CO_2 eq.)

**Each Party may produce the controlled substances for basic domestic needs in developing countries beyond the controlled level and essential or critical uses such as laboratory and analytical uses are exempted from control. For the HFC phase down, a high ambient temperature exemption shall be available to Parties with high ambient temperature conditions.

Japan's efforts

Japan has been promoting the energy efficient technologies / equipment of using natural refrigerants. The Ministy of the Environment (MOE) has been providing financial support for the domestic enterprises that install such equipment. Many enterprises has received the subsidies so far.

Examples of refrigeration equipment installed with the subsidies of MOE

refrigerant	application	improvement of energy efficiency
CO_2	commercial refrigeration (super market)	approx. 20% reduction of energy consumption
NH_3 (ammonia)	cold storage warehouse	more than 25% reduction of energy consumption annually
Air	ultra-low temperature warehouse (< - 60 ℃)	approx. 40% reduction of energy consumption depending on the season

The ammonia refrigeration system

The air refrigeration system

Japan's commitment

Japan has been committed not only to achieving its own obligations under the Montreal Protocol but also to assisting other countries, mainly those in Asia and the Pacific region, based on its experience in policy enforcement and technical development. The Ministry of the Environment of Japan has been working through the Regional Network Meetings of Asia and the Pacific, and through the Multilateral Fund for the Implementation of the Montreal Protocol, including the HPMP refrigeration servicing sector of China and Mongolia, and the HPMP foam manufacturing sector of Mongolia.

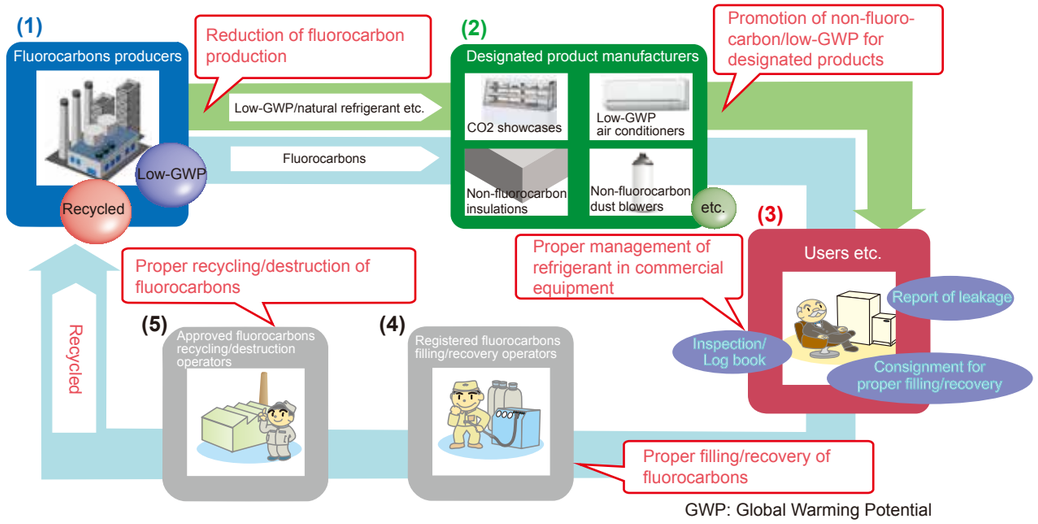
Second Global Inter-Regional and Parallel Networks Meeting for National Ozone Officers. Paris, France. February 2019.

Thematic Workshop for National Ozone Officers of South Asia Network. Ulaanbaatar, Mongolia. August 2019.

Comprehensive measures throughout the life cycle of fluorocarbons

In Japan, CFCs, HCFCs, and HFCs have been recovered from commercial refrigerators and air conditioners at the time of maintenance and disposal of equipment since 2001 in line with a law and have been recycled or destroyed in order to prevent fluorocarbons from being released into the air.
In 2015 and 2019, the concerned law was amended and strengthened to implement comprehensive measures throughout the life cycle of fluorocarbons.
The recovery rate of fluorocarbons is expected to be improved from approx. 40% currently to 50% in 2020 under the amended law, and further measures will be taken aiming to achieve 70% in 2030.

Life cycle of fluorocarbons



Major responsibilities of stakeholders

(1) Fluorocarbons producers

Manufacturers and importers of CFCs, HCFCs, and HFCs must be received permission and assigned quota systems. Moreover, they must rationally use fluorocarbons, including the production of alternatives following the criteria established by the government.

(2) Designated product manufacturers

Manufacturers and importers of designated product must strive to reduce environmental impact due to fluorocarbons in accordance with the evaluation criteria established by the national government.

The target GWP value of the designated products is set by category and periodically reviewed taking into consideration the lowest GWP refrigerant (the top runner) among the designated products in the market in Japan, taking into account safety, energy efficiency, affordability, etc.
Manufactures and importers of the designated products are required to meet the target GWP value by the target year of the corresponding category. The compliance with the target value is measured for each category based on the volume weighted average GWP of all the refrigerants, blowing agents, or propellant gases contained in all the products that are shipped by each company in each year, not on the basis of individual products.

Designated products	Main refrigerants currently used (GWP)	Target GWP value	Target year
Room air-conditioner (except Through-the-Wall type)	R-410A (2,090)	750	2018
	HFC-32 (675)		
Commercial air-conditioner (for stores, shops and offices)			
a. < 3 t of cooling capacity, excluding floor type	R-410A (2,090)	750	2020
	HFC-32 (675)		
b. ≥ 3 t of cooling capacity, excluding c (below) and floor type	R-410A (2,090)	750	2023
c. Central air conditioner using centrifugal chiller	HFC-134a (1,430)	100	2023
	HFC-245fa (1,030)		
Mobile air conditioner (for passenger vehicles of passenger capacity less than 11 people)	HFC-134a (1,430)	150	2023
Condensing unit and refrigerating equipment (except condensing unit with rated output of 1.5 kW or lower)	R-404A (3,920)	1500	2025
	R-410A (2,090)		
	R-407C (1,774)		
	CO_2 (1)		
Central refrigeration system (for 50,000 m3 and more, new facilities)	R-404A (3,920)	100	2019
	Ammonia (1)		
Rigid urethane foam insulation (for spray foam for house building materials)	HFC-245fa (1,030)	100	2020
	HFC-365mfc (795)		
Dust blower (Except application that requires non-flammable)	HFC-134a (1,430)	10	2019
	HFC-152a (124)		
	DME (1)		

(3) Users/ maintenance operators/ disposal operators of specified products

Users of specified products inspect the equipment. They must report the calculated leakage amount to the government if there is leakage of a certain amount or more of fluorocarbons.
When the disposal, users must submit a certificate of recovery to recycling/destruction operators, and fluorocarbons recycling/destruction operators must receive the certification of recovery from the users, otherwise, they both get a penalty.

(4) Registered fluorocarbons filling/recovery operators

Registered fluorocarbons filling/recovery operators must comply with the filling/recovery criteria in filling or recovering fluorocarbons. If they do not recycle recovered fluorocarbons by themselves, they must deliver fluorocarbons to an approved fluorocarbon recycling operator or an approved fluorocarbon destruction operator.

(5) Approved fluorocarbons recycling/destruction operators

Approved fluorocarbons recycling/destruction operators must recycle or destroy delivered fluorocarbons in accordance with the standards for the recycling/destruction of fluorocarbons.

- Specified products are commercial refrigerators and air conditioners containing fluorocarbon refrigerants. (Automobiles' mobile air conditioners are sepately regulated under a different law, i.e. the "End-of–life Vehicle Recycling Law".)

Recovery, Recycling & Destruction of CFC, HCFC, & HFC

In Japan, CFCs, HCFCs, and HFCs are controlled and they must be recovered from home appliances, cars, and commercial equipment when the equipment containing these gases is discarded. Recovered gas must be recycled or destroyed, instead of being released into the air.

Household end-of-life refrigerators, freezers, A/C and heat-pump washer-dryers

Will be recovered under "Home Appliance Recycling Law"

Request the shop from which you bought the end-of-life product or the shop from which you buy a new product to take back the end-of-life product

Pay for collection, transportation and recycling when handing over the end-of-life product

*Price for collection and transportation differs between shops.
*Recycling fee differs between product manufacturers.

After you have paid the recycling fee, request the shop to issue a home appliance recycling ticket

You can monitor the status of recycling on the Internet with the ID number on the ticket.

Fluorocarbons → Recovered for recycling or destruction

Iron, aluminum, etc. → Recycled as resources

End-of-life automobiles

Will be recovered under "End-of-life Vehicle Recycling Law"

Hand over the end-of-life vehicle to collection operators registered with local governments. (Car dealers or servicing workshops)

Pay recycling fee

*Recycling fee differs between car manufacturers.

When and to whom to pay

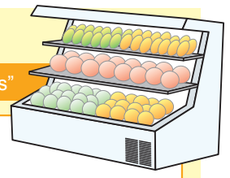
*Purchase of a new car	When purchasing	To the car dealer
*For already owned cars	Before next periodical inspection	To Transport Bureau or servicing workshops
When you discard a car before next automobile inspection	When discarding	To the collection operator

*Once the payment has been made at the time of purchase or periodical inspection, no more payment is required at the time of discarding the vehicle

Fluorocarbons → Recovered for recycling or destruction

Iron, aluminum, etc. → Recycled as resources

Service or discard of commercial refrigeration and A/C



Will be recovered under the "Act on Rational Use and Proper Management of Fluorocarbons"

- Commercial A/C
- Cold showcase and freezers
- Commercial refrigerators and freezers
- Freezing units for transportation

Those who wish to discard any of the listed above equipment must…

Request Fluorocarbon recovery operators registered with prefectural governments to recover fluorocarbons

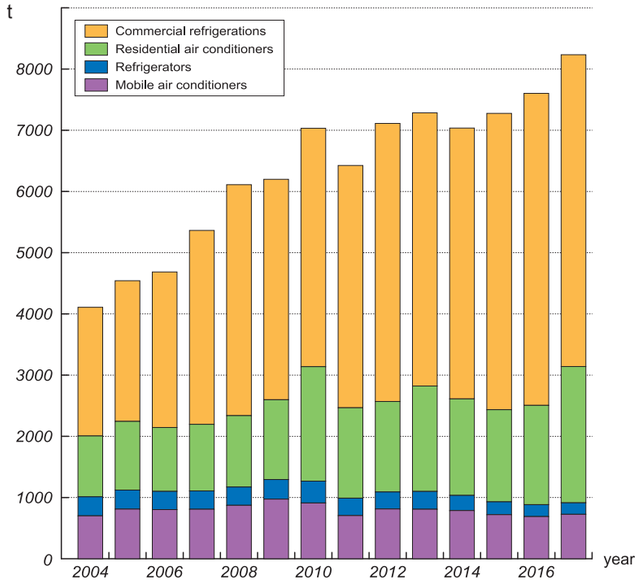
When requesting a Fluorocarbon recovery operator (i.e. car dealers or servicing workshops) registered with a prefectural or municipal government with a public health center to recover fluorocarbons,

1) Issue a "Recovery request form" or a "Consignment confirmation form" in accordance with the relevant law. (They are applied only at the time of a disposal.)

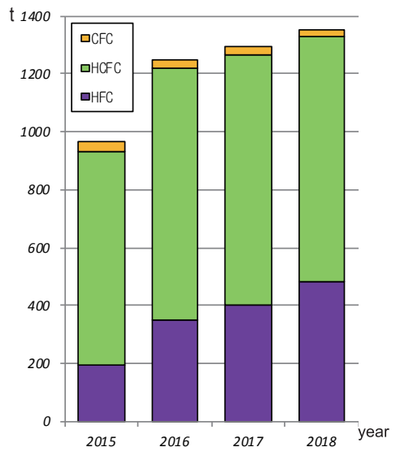
2) Pay the fee for recovery, recycling and destruction of fluorocarbons.

In Japan, there are about 60 home-appliance recycling plants, more than 25 F-gas recycling facilities and more than 60 F-gas destruction facilities in commercial operation using various technologies such as superheated steam, municipal waste incinerators, cement kiln, etc
More than 8,000 tons of refrigerant CFC, HCFC and HFC was recovered from equipment in Japan in 2017, and more than 1,300 tons of refrigerant was recycled and about 4,400 tons of refrigerant was destroyed in Japan in 2018.

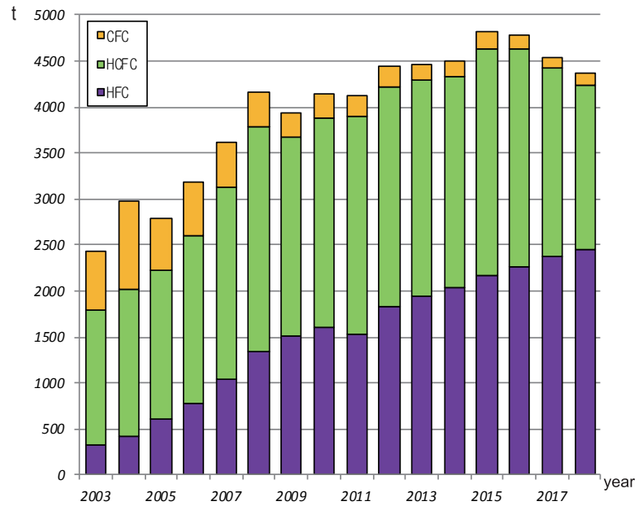
Recovery of refrigerant from super-market cold showcase
Source: Refrigerants Recycling Promotion and Technology Center, Japan



Amount of recovered refrigerant in Japan
Source: Ministry of the Environment, Japan



Amount of recycled refrigerant in Japan
Source: Ministry of the Environment, Japan



Amount of destroyed refrigerant in Japan
Source: Ministry of the Environment, Japan