70 100 130 160 190 220 250 280 310 340 370 400 (DU)

Ozone hole

The illustration on the cover shows the distribution of ozone above the Antarctic in October 2015 (the monthly average in Dobson Unit) based on the data of the Japan Meteorological Agency.

Ozone hole
2015.10

Antarctica

Let's protect the ozone layer

2016 edition

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Government of Japan
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URL: http://www.env.go.jp/en/

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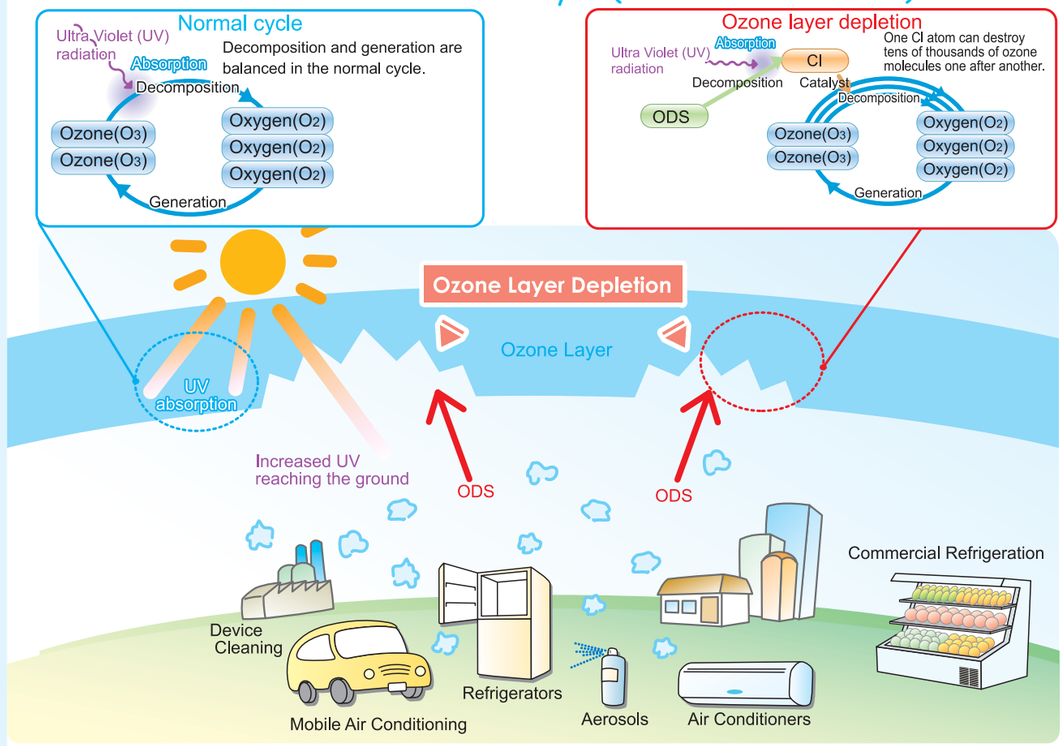
Ministry of the Environment
JAPAN

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

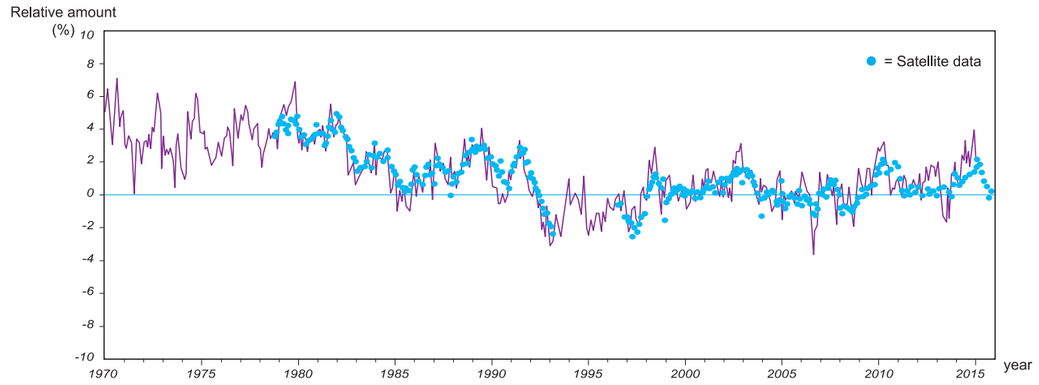
Eye

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.

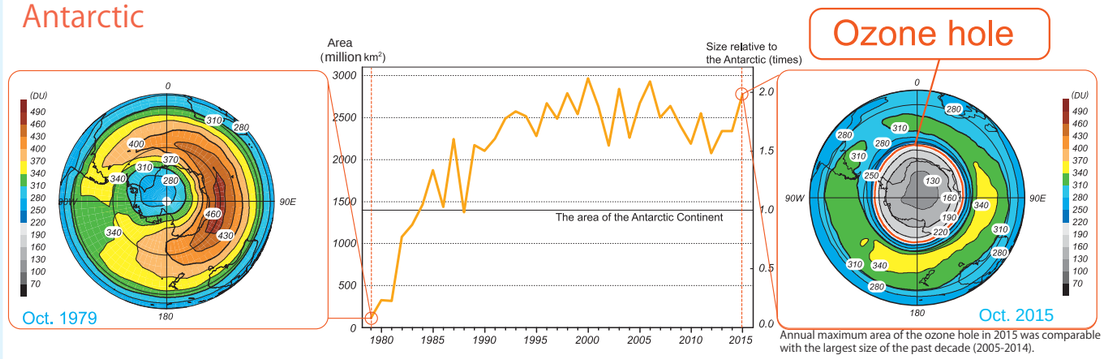
The amount of the ozone in the ozone layer decreased in the 1980s and the early 1990s. Although it picked up slightly in the recent years, the amount of ozone in the ozone layer continues to be smaller than before.

Global



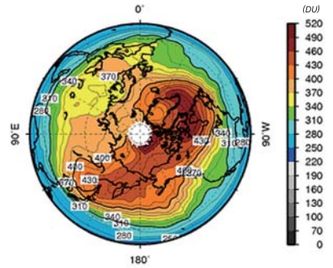
Time series in global mean total ozone
Source: Japan Meteorological Agency

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" because it looks like a hole in the sky in a satellite image of ozone density in the Antarctic.
In addition, a group of scientists found the ozone depletion of a comparatively large scale above the Arctic in March and April 2011 for the first time in history.

Source: National Institute for Environmental Studies of Japan

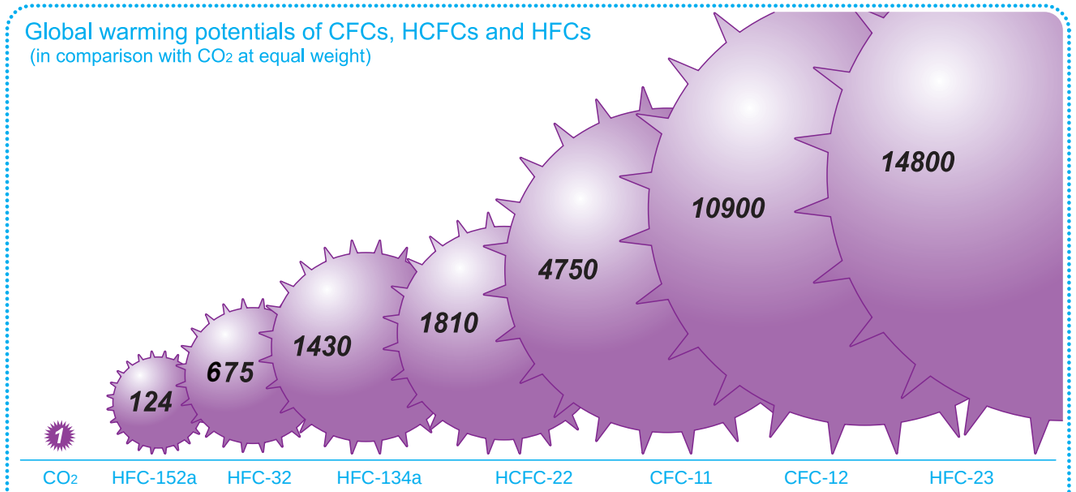
Ozone Depleting Substances & Climate Change

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)



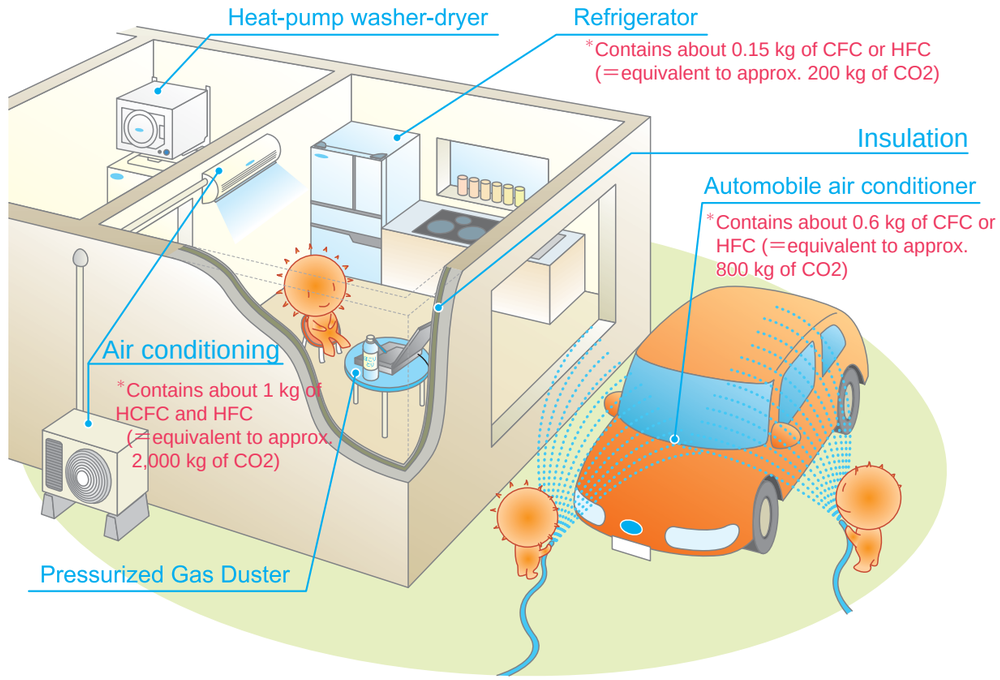
Figures have been taken from IPCC fourth assessment report (2007)

	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
Fluorinated gases controlled by Kyoto Protocol	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

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...



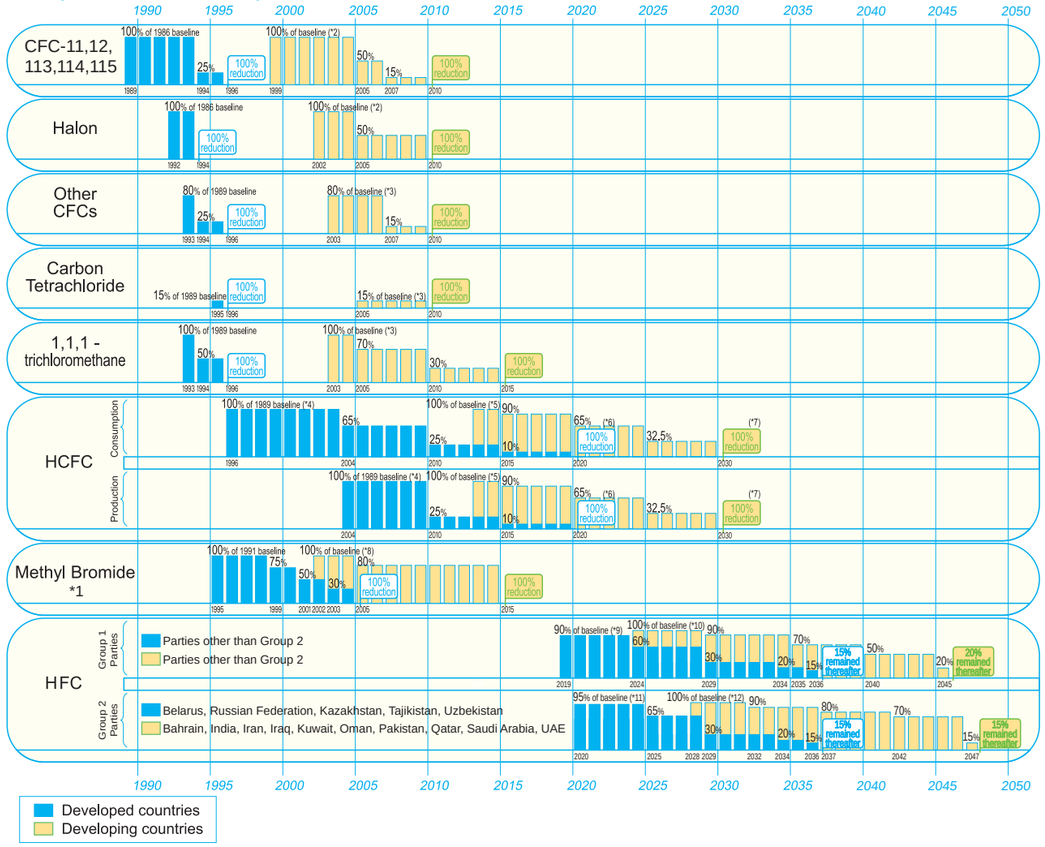
Global Efforts & Japan's Commitment

In order to protect the ozone layer, the global community has agreed to phase out ozone-depleting substances under the Vienna Convention for the Protection of the Ozone Layer (1985) and the Montreal Protocol on Substances that Deplete the Ozone Layer (1987).

Furthermore, in Oct. 2016, at the 28th Meeting of the Parties (MOP 28) to the Montreal Protocol, the Parties adopted the amendment (called the Kigali Amendment) to phase down HFCs in order to reduce the use of high global warming potential HFCs.

With 197 countries working together, both developed and developing countries, the Montreal Protocol is a global environmental treaty of universal ratification.

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



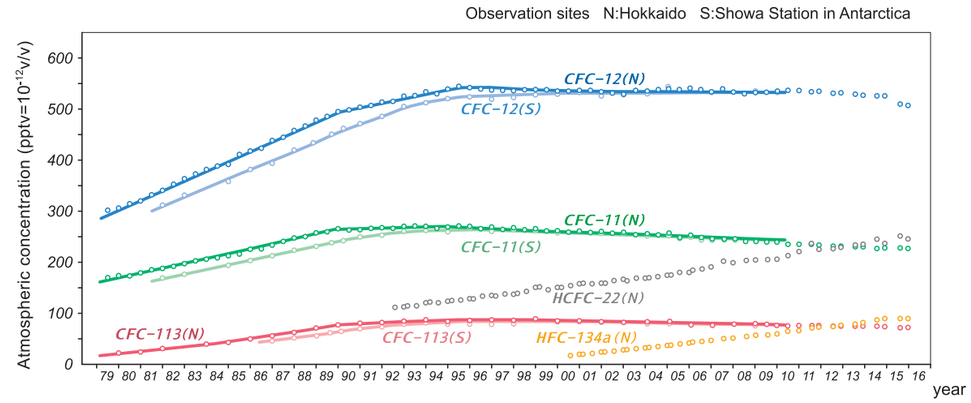
Production and consumption (= production + import - export) are to be phased out by substance group according to specific schedules.

*1) Methyl bromide used for quarantine 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% (CO2 eq.)
*10) Baseline = the average of HFC production and consumption from 2020 to 2022 + the baseline of HCFC production and consumption x 65%(CO2 eq.)
*11) Baseline = the average of HFC production and consumption from 2011 to 2013 + the baseline of HCFC production and consumption x 25% (CO2 eq.)
*12) Baseline = the average of HFC production and consumption from 2024 to 2026 + the baseline of HCFC production and consumption x 65% (CO2 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.

Visible effect of the Montreal Protocol

The actual data of the concentration of ozone depleting substances in the air show that the Montreal Protocol has been effective in curbing the increase of CFCs in the air.



Changes in the atmospheric concentration of ODS (CFCs and HCFC-22) and HFC-134a

Source: The University of Tokyo and MOE

International cooperation

Japan has been committed not only to achieving its own obligations under the Montreal Protocol but also to assisting other countries, particularly 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 HPMP foam manufacturing sector of Mongolia.

The Asia and the Pacific Joint Network Meeting. Suva, Fiji. June 2016.

The verification site visit for the technology conversion project of XPS foam manufacturing companies in Mongolia. September 2016.

The Coordination Meeting on the preparation of stage II of the HPMP for China.
Beijing, China. January 2016.

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

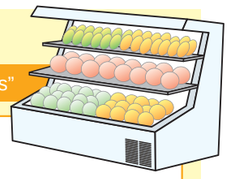
*Purchase of a new car	When purchasing	To the car dealer
*For already owned cars	Before next periodical inspection	To Transport Bureau or servicing workshops
When you discard a car before next automobile inspection	When discarding	To the collection operator

*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

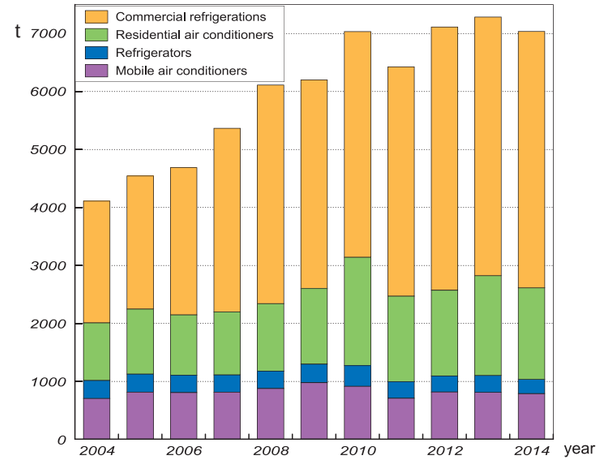
When requesting a Fluorocarbon recovery operator (i.e. car dealers or servicing workshops) registered with a prefectural or municipal government with a public health center to recover fluorocarbons,

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.)

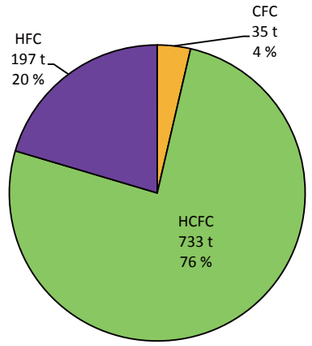
2) Pay the fee for recovery, recycling and destruction of fluorocarbons.

In Japan, there are more than 40 home-appliance recycling plants, more than 20 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 7,000 tons of refrigerant CFC, HCFC and HFC was recovered from equipment in Japan in 2014, and about 965 tons of refrigerant was recycled and about 4,800 tons of refrigerant was destroyed in Japan in 2015.

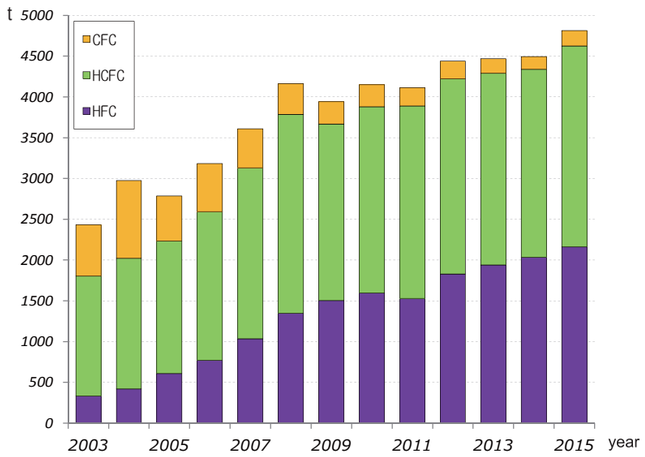
Recovery of refrigerant from super-market cold showcase
Source: Refrigerants Recycling Promotion and Technology Center, Japan



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



Amount of recycled refrigerant in Japan in 2015
Source: Ministry of the Environment, Japan



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

Type	Technology	Decomposition capacity (indicative)
Devoted system	Superheated steam	25 kg/h
	Submerged combustion	10 kg/h – 300kg/h
	Ark plasma	Large 10 kg/h Small 1 kg/h – 2 kg/h
	Solid alkali reaction	10 kg/h
	Catalyst	6 kg/h
Multipurpose system	Municipal waste incineration	10 kg/h – 120 kg/h
	Cement kiln,Lime calcination furnace	10 kg/h – 50 kg/h
	Electric furnace	50 kg/h

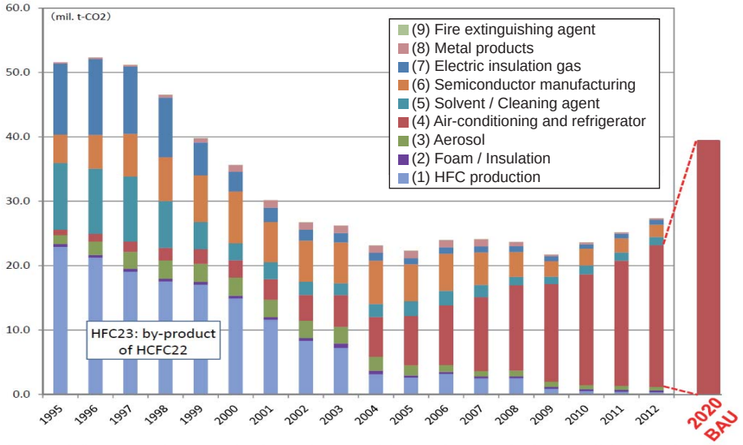
Major F-gas destruction technologies in use in Japan and their capacity ranges

Comprehensive measures throughout the life cycle of fluorocarbons

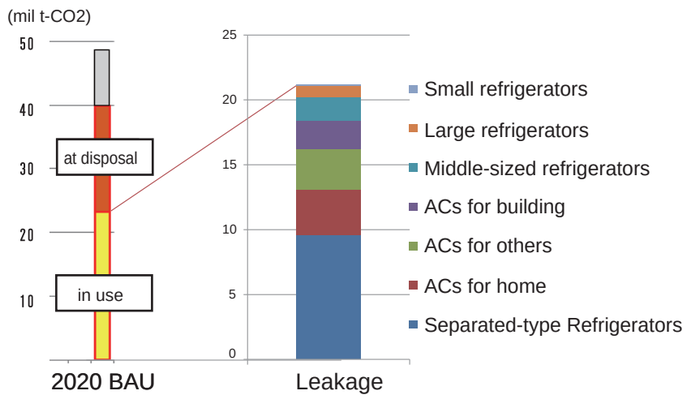
In Japan, since 2001 under the "Law Concerning the Recovery and Destruction of Fluorocarbons", CFCs, HCFCs, and HFCs have been recovered from commercial refrigerators and air conditioners at the time of maintenance and disposal of equipment and have been recycled or destroyed in order to prevent fluorocarbons from being released into the air.

However, HFCs emissions have been increasing rapidly and are expected to double in 2020 as compared to the emissions in 2011 from refrigeration and air conditioning equipment. The recovery rate of fluorocarbons from end-of-life commercial refrigerators and air conditioners remained low (about 30%) and it was found out that refrigerant leakage from the equipment in use was much higher than expected due to poor maintenance, aging, etc.

In light of this, the government of Japan decided to amend and strengthen the "Law Concerning the Recovery and Destruction of Fluorocarbons" in order to implement comprehensive measures throughout the life cycle of fluorocarbons. The amended law has come into force on 1 April 2015 as the "Act on Rational Use and Proper Management of Fluorocarbons".



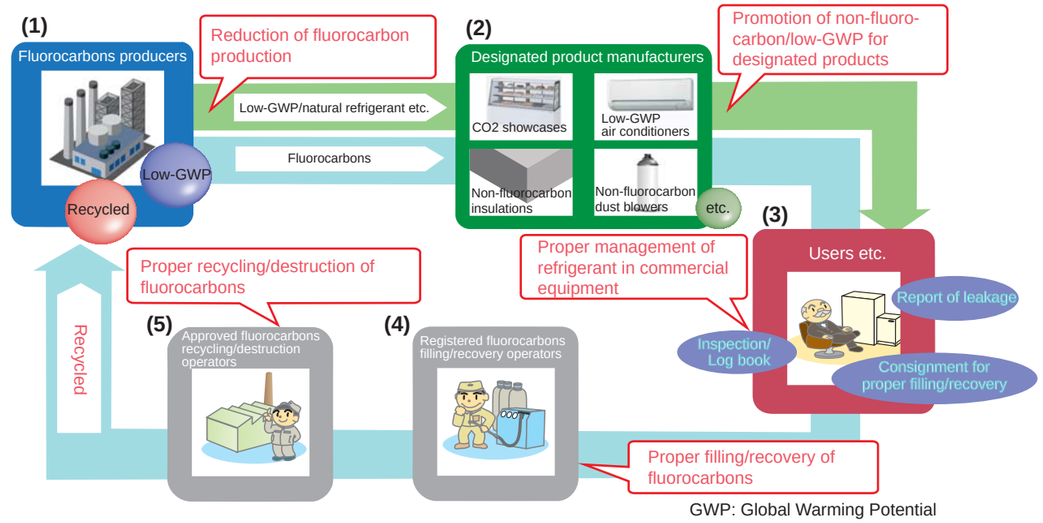
Estimated fluorocarbon emissions from refrigeration and air-conditioning in 2020



Estimated fluorocarbon emissions and leakages by sector in 2020 (BAU)

Outline of the Act on Rational Use and Proper Management of Fluorocarbons

Life cycle of fluorocarbons



GWP: Global Warming Potential

Major responsibilities of stakeholders

＜Measures for the rational use of fluorocarbons＞

(1) Fluorocarbons producers

Producers and importers of fluorocarbons must make the rational use of fluorocarbons, including the production of alternatives for fluorocarbons in accordance with the evaluation criteria established by the national 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.

＜Measures for proper management of fluorocarbons used for specified products＞

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

Users of specified products carry out inspection of the equipment in accordance with the evaluation criteria for initiatives by users.

They must report calculated leakage amount to the national government if there is leakage of a certain amount or more of fluorocarbons.

When filling and recovery of fluorocarbons or disposal of equipment (including transfer of equipment for the purpose of using it as the raw material or parts of new equipment) is necessary, maintenance operators and disposal operators of specified products must consign filling/recovery of fluorocarbons or deliver fluorocarbons to a registered filling/recovery operator.

(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".)